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Agricultural Libraries and Information

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University of Illinois
Graduate School of Library
and Information Science

LIBRARY
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Library Trends, a quarterly thematic journal, focuses on current trends in all areas of library practice. Each issue addresses a single theme in-depth, exploring topics of interest primarily to practicing librarians and information scientists and secondarily to educators and students.

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We encourage our readers to submit ideas for future *Library Trends* themes; issue topics are developed using reader suggestions and recommendations from members of the Publications Committee. We also encourage readers to volunteer to be issue editors or to suggest others who may be willing to be issue editors.

The style and tone of the journal are formal rather than journalistic or popular. *Library Trends* reviews the literature, summarizes current practice and thinking, and evaluates new directions in library practice. Papers must represent original work, Extensive updates of previously published papers are acceptable, but revisions or adaptations of published work are not sought.

An issue editor proposes the theme and scope of a new issue, draws up a list of prospective authors and article topics, and provides short annotations of the article's scope, or else gives a statement of the philosophy guiding the issue's development. Please send your ideas or inquiries to F.W. Lancaster, Editor, Publications Office, 249 Armory Building, 505 E. Armory Street, Champaign, IL 61820-6291.

ERRATA

In Volume 38, Number 2 of *Library Trends,* due to our error, the order of the articles in the issue do not correspond to the order that they are mentioned in Ronald Powell's introduction. *Library Trends* apologizes to Mr. Powell and its readers for this oversight.

Agricultural Libraries and Information

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Introduction

KEITH W. RUSSELL AND MARIA G. PISA

FINDING COMMON GROUND from which to discuss agricultural libraries and information services can be a difficult task. The array of users, institutions, and disciplines that participate in and help shape the provision of agricultural information represent a patchwork of different (and at times radically different) needs, interests, philosophies, and influences. This *Library Trends* issue attempts to find a common ground by covering a full range of topics on agricultural libraries and information services worldwide. It reflects the state of the art, identifies future trends and directions, and relates the present and future to the past.

This work is designed to serve as a handbook for agricultural (and other science) librarians and also can be useful to researchers, practitioners, and administrators in agriculture and related fields. The authors represent a variety of perspectives. They come from universities, library schools, national libraries, and international research and funding organizations. While all are associated with institutions in the United States and Canada, many have international experience. Some are currently involved in provision of basic and advanced services to agriculturists; others are managers in the provision of such services or in the management of the agricultural information system.

This volume covers the acquisition, management, and dissemination of agricultural information of all types and in all formats, as well as the infrastructure of agricultural information worldwide. In doing so, the articles in this issue:

1. *provide an overview of what we know today, how we came to know it, and where that knowledge is documented in the literature or in*

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human resources. Beth Paskoff begins the issue by tracing the development and growth of agricultural libraries and information services in the United States;

2. *identify established and emerging trends, as well as the convergence of trends that suggest where things may end up if courses are not altered or additional resources and ways of thinking are not found to modify the rate and direction of change.* Jan Kennedy-Olsen discusses the management of trends in agricultural libraries and highlights the significance of such issues as the changing paradigm of librarianship, the crises in publishing and preservation, the cost and accessibility of electronic data. Carol Ditzler, Veronica Lefebvre, and Barbara Thompson discuss several trends and practices to help guide document delivery specialists through the next decade, including a consideration of strategic planning issues to enhance service options, education and training, and collection development; the adoption of entrepreneurial attitudes, values, and practices; the incorporation of new technology into daily routines; and the establishment of stronger networks;
3. *highlight some of the basics that are important in the field.* Rita Fisher and Michael Kinch survey the major issues and trends in agricultural reference services as they affect user education, bibliographic searching, communications, collections, and staffing. Beverlee French examines the users of agricultural information and characterizes their information-seeking behaviors, information needs, and responses to library services. She explores the effects of these characteristics on the role of the information professional and on the provision of library services, and considers the relationship of the agricultural library to the agricultural community. Nelda Elder, Brice Hobrock, Debora Madsen, and William Wiese discuss collection development, selection, and acquisition techniques applicable to agricultural libraries. The special challenges that exist for librarians and agricultural specialists who select and acquire agricultural collections are reviewed;
4. *elucidate possible solutions to library and information problems.* Eleanor Frierson and Georg Lindsey discuss several technological solutions under development at specific institutions and their potential uses for the management of international agricultural information. They identify four technologies as being especially important—telecommunications; optical media, including CD-ROM; data conversion technologies; and expert systems and artificial intelligence;
5. *raise a number of important questions related to international agricultural information.* Doug Jones provides an overview of the types of agricultural information, the formats for its storage and distribution, the organizations that help create and disseminate it, as well as where it may be found and how it may be accessed. He identifies

several important questions: given limited resources, what should a library try to collect? How can the library community ensure that all nonephemeral materials are collected and made available by at least one institution? What can be done to improve the identification and bibliographic control of library materials? and

6. *review some of the most useful recent literature on agricultural information, information science, library science, and agricultural and scientific research.* The paper by Jim Bird and Jessie Smith, an annotated bibliography, provides a common base of key documents for understanding the status of agricultural information and agricultural libraries. The bibliography plus the references in the articles demonstrate that much relevant information comes from fields outside library science.

In some respects, the image that emerges of agricultural libraries and librarians is not always encouraging. Efforts to collect, control, and disseminate agricultural information are beset by various problems. For example, Sarah Thomas points out that, while several new technologies hold promise, the process of bibliographic description and analysis is still labor intensive for the most part and that much of the effort expended to create a bibliographic record remains manual. Although several cooperative efforts are underway to minimize duplication of effort in establishing bibliographic control over agricultural materials, she predicts that some overlap between and among agricultural databases will continue for the near future.

It also is evident that we do not know much about some aspects of the agricultural information network. However, given what we do know about the current state of the agricultural information infrastructure throughout the world, and about solutions that have worked in some countries, is there a way to hasten the evolution of the agricultural information network country by country? Consider the Plucknett and Smith article mentioned in several articles in this issue. The article concerns international agricultural research, not libraries, but the basic principles upon which successful research networks are founded also apply to agricultural library networks (and library networks in general). In separate papers and from different perspectives, Martha Stone and Susan Harris refer to the Plucknett and Smith principles in their discussions of the present and future status of agricultural information networks. A careful reading of their articles enables one to begin to diagram the evolution of the information structure, list the qualities of more advanced systems, and suggest elements needed for progress to be made.

The articles in this issue document a large number of changes that have occurred in recent years in the agricultural information system. Such changes include a variety of sophisticated cooperative ventures in bibliographic control, technology development, networking, and other areas. Another change is the increase in both the number of individuals and organizations that focus on the world picture of agricultural information and the intensity of their efforts. The current roles and activities of many organizations are different from what they were a few years ago: the U.S. Agricultural Information Network (which did not exist until 1988), the Consultative Group on International Agricultural Research, the International Association of Agricultural Librarians and Documentalists, the Food and Agriculture Organization of the United Nations, CABI, and the Technical Center for Agricultural and Rural Cooperation, among others. The pressures toward cooperation, the increased number of players and their increased inclination to cooperate, and the development of technologies that facilitate communication and cooperation all seem to have changed the current scene. The time appears to be right for agricultural information services to enter a new elevated phase of activity.

This issue of *Library Trends* presents the visions of various authors. It is hoped that there exist common elements in these visions that can serve as guidelines for future actions.

History and Characteristics of Agricultural Libraries and Information in the United States

BETH M. PASKOFF

ABSTRACT

AGRICULTURE AND THE NEED for agricultural information have existed for thousands of years. In colonial America, the earliest agricultural information came from Europe, but by the time of the American Revolution domestic agricultural publications and agricultural libraries existed. The earliest U.S. agricultural libraries were those in professional associations and scholarly societies. Agricultural libraries have also been created to serve state and national government agencies. The most important government library is that of the U.S. Department of Agriculture (USDA), which dates from 1839. As the National Agricultural Library (NAL), it is today one of the most significant and comprehensive agricultural libraries in the world. Academic agricultural libraries, including those in experiment stations, have supported agricultural research and education in the United States since the mid-nineteenth century. In the twentieth century, corporate agricultural libraries have come into existence. The number and variety of agricultural libraries provide a wide variety of information and services.

INTRODUCTION

Agriculture has been a part of human life for many thousands of years; the need for agricultural information is probably almost as old. Ancient Babylonian clay tablets have been found that contain agricultural information. Blanchard (1977) hypothesized that "the great library at Alexandria undoubtedly had many treatises on agriculture inscribed on papyrus" (p. 219). Throughout history, in many civilizations, there have been libraries that have included agricultural information, and

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separate agricultural libraries were established in Europe in the mid-eighteenth century. The development and growth of agricultural libraries and agricultural information in the United States will be reviewed in this article.

AGRICULTURAL INFORMATION

Agriculture, the science of raising crops and animals, began some 10,000 years ago in the Middle East when animals were first raised in captivity. Most agricultural information from that time until the mid-nineteenth century was passed from one farmer to another by word of mouth. Even during the early days of the Agricultural Revolution, when advances in crop rotation, animal breeding, and mechanical inventions led to increased productivity and the need for fewer agricultural workers, most individuals learned of these developments from other farmers.

Fusonie (1975) noted that, at the time of the American Revolution, 90 percent of the American people were farmers. During the years following the revolution: "New advances in agricultural technology and increased dissemination of knowledge through agricultural literature inclusive of monographs, published works of agricultural societies, and the growing number of periodicals finally culminated in what became known as the first Agricultural Revolution" (p. ii).

Before programs of agricultural education were established, scientific societies and agricultural fairs offered slightly more formal exchanges of information in the early nineteenth century. The first agricultural fairs in the United States were that of the Columbia Agricultural Society in the Washington, D.C. area in 1809 and that of the Berkshire County Agricultural Society held in Pittsfield, Massachusetts, in 1811. Marti (1986) noted that "agricultural fairs have always claimed to be educational. Their eighteenth-century founders believed that science could elevate farming... and they tried to diffuse its light among the folk who worked the land" (p. 1).

The first publications devoted to agriculture came to the United States from Europe. Prior to and following the American Revolution

> gentlemen farmers in the colonies continued to communicate with leading agriculturalists across the Atlantic. These men kept themselves abreast of the latest advancements occurring in agriculture abroad, through correspondence as well as through the acquisition of outstanding books, treatises, and journals . . . . (Fusonie, 1976, p. iii)

Private collections of some note were developed and "the greater part of the library work for agriculture in those early days was undoubtedly done in the private collections..." (Greathouse, 1899, p. 496). More than 50 of the 900 volumes in George Washington's collection were on agriculture, while Thomas Jefferson's large collection included 133 agricultural books which were part of the collection sold to the Library of Congress in 1815 (Blanchard, 1977, p. 220).

Some of the first English language works on agriculture were Blith's *English Improver, or a New Survey of Husbandry* (London, 1649), Worlidge's *Two Treatises on Husbandry, Cyder and the Cyder Mill* (London, 1694), and Jethro Tull's *The Horse-Hoeing Husbandry* published in 1731. Richard Weston's 1779 publication, *Tracts on Practical Agriculture and Gardening In Which the Advantage of Imitating the Garden Culture of the Field is Fully Proved, by a Seven-Years Course of Experiments. Particularly Addressed to the Gentlemen Farmers in Great Britain. With Observations Made in A Late Tour Through Parts of France, Flanders, and Holland. Also Several Useful Improvements in Stoves and Green-Houses To Which is Added A Complete Chronological Catalogue of English Authors on Agriculture, Gardening, etc.* was popular in North America (Moran, 1976). Among the earliest agricultural works published in the United States were the *Farmer's Assistant,* written by John Nicholson in 1814, and the *Farmer's Library* by Leonard E. Lathrop, published in 1826-27. Fusonie (1988) noted that "In 1828, Congress issued the first technical publication in the field of agriculture entitled *Manual on the Growth and Manufacture of Silk and Treatise on the Rearing of Silk-Worms* authored by Joseph Ritter Von Hazzi. The first U.S. agricultural periodicals included the *Agricultural Museum* in 1810 and the *American Farmer,* which began publication in 1819 (Thurber, 1945).

Although there were some significant agricultural publications at this time, Greathouse observed in 1899 that:

> In those early days agricultural books were no more numerous in general libraries than at the colleges, and were probably not as much used. Everywhere theology first by far, then law, medicine, history, travels made up the great body of the books in the libraries outside of such as were devoted to mere amusement. The volumes on agriculture in the classic tongues were about as numerous as those in modern languages, and were generally better known. (p. 495)

A complete list of the early agricultural publications can be found in Fusonie's *Heritage of American Agriculture: A Bibliography of Pre-1860 Imprints* (1975).

The use of agricultural information is different from that of other disciplines in science and technology. There is a significant volume of scholarly publication based on agricultural research conducted in universities and government agencies, but, unlike the applied disciplines of medicine and engineering, the practitioner of agriculture—the farmer—may not utilize the research or even be aware of its existence. Lancaster and Beecher (1981) point out that: "The results of agricultural research must be presented in one form for the research community and in a completely different form for the farming community or for the extension agents who carry information to this community" (p. 199).

Blanchard (1977) identified three categories of agricultural literature. The most important was the research literature that is available in scholarly journals, experiment station bulletins, and books. Farmers and agricultural extension service agents relied most on "extension type publications distributed by experiment stations and extension services" (p. 224). The third category was trade publications including journals for the farmer and the agricultural industry.

Lancaster and Beecher (1981) observed that "agriculture is perhaps the most interdisciplinary of all the spheres of human activity, drawing, as it does, from biology, medicine, chemistry, soil science, various branches of engineering, climatology, food technology, the environmental sciences, economics, management, and a whole host of other fields" (p. 197). This was equally true in the eighteenth and nineteenth centuries, and early agricultural libraries included many works on chemistry, engineering, and the weather.

Types of Agricultural Libraries

Several types of agricultural libraries are found in government agencies, academic institutions, corporations, and trade and professional associations. Each type of library was developed to meet a different need and to serve a different group of users. The current characteristics and distribution of agricultural libraries will serve as an introduction to the history of such libraries.

The number of agricultural libraries in the United States has increased over the last two centuries although fairly slowly; Greathouse identified seventy-seven agricultural libraries in 1899. Blanchard (1977) noted that there were 125 agricultural libraries in the United States in 1934 and 215 in 1959 (p. 225).

The 227 agricultural libraries in the United States and Canada that are listed in the *Directory of Special Libraries and Information Centers* (1985) served as the population for an analysis of contemporary agricultural libraries. This is not a comprehensive list of agricultural libraries but does provide a variety of data to be analyzed.

As shown in Table 1, the majority of these libraries are located in either government agencies or academic institutions. The academic libraries are usually associated with large land-grant institutions. The government libraries range in size from small state agency libraries, such as that of the Minnesota State Board of Animal Health, to the extensive collections at the National Agricultural Library. The corporate libraries provide information for firms that specialize in farm equipment, agricultural chemicals, plant and animal genetics, agribusiness, or specific agricultural products such as tobacco, sugar, or livestock. Agricultural libraries in trade and professional associations include those of the American Seed Trade Association, the National Association of Animal Breeders, and the United Farm Workers of America.

Although many libraries in this directory did not report the year in which they were founded, at least seventeen of the agricultural libraries

TABLE 1
TYPES OF AGRICULTURE LIBRARIES

Types of Agriculture Libraries in the U.S. & Canada	*Number*	*Percentage*
Academic	71	31.3
Federal Government	75	33.0
State/Provincial Government	18	7.9
Trade/Professional Association	30	13.2
Corporation	28	12.4
Other	5	2.2
Total	227	100

Source: *Directory of special libraries and information centers.* (1985). 9th ed. Detroit, MI: Gale Research Co.

that are still in existence were founded before 1900. Another twenty-one were founded between 1900 and 1929, and twenty in the two decades between 1930 and 1949. The recent decades were especially fruitful times for library growth: twenty-nine libraries were founded during the 1950s, twenty in the 1960s, and eighteen in the 1970s. Blanchard (1977) notes that all of the corporate agricultural libraries have been established in the years since World War I.

Typical of special libraries, many of the agricultural libraries reported having small specialized collections. Thirty-three libraries (14.5 percent) have fewer than fifty serial subscriptions, and a total of ninety-eight (43.1 percent) have fewer than 250 subscriptions. Monographic collections are equally small with seventy-eight (34.4 percent) of the libraries reporting fewer than 2,000 titles. Of course, large agricultural collections do exist, notably those at the National Agricultural Library and some academic libraries. Thirty-five (15.4 percent) of the agricultural libraries have more than 1,000 subscriptions, and twenty (8.8 percent) have collections of more than 100,000 volumes.

The size of the staffs of the agricultural libraries is also varied. Thirty libraries (13.2 percent) reported no professional staff, and eighty-three (36.6 percent) had only one professional librarian. While fifty-seven (25.1 percent) of the libraries had one paraprofessional staff member, forty-three (18.9 percent) reported no such staff at all. Only 106 (46.7 percent) of the libraries reported that they were using computers at that time. One hundred fifty-nine libraries (70.1 percent) do offer interlibrary loan to their users, but only thirty (13.2 percent) have instituted current awareness services. The vast majority, 187 libraries or 82.4 percent, reported that the library is open to members of the public who may need to use the specialized collections.

LIBRARIES OF PROFESSIONAL ASSOCIATIONS AND SCHOLARLY SOCIETIES

Among the earliest libraries in the United States were the libraries of scientific societies. The specialization and scientific developments of the latter part of the eighteenth century led to the formation of agricultural societies to further the interests of farmers. Similar societies had already proven to be successful in Europe. One of the first such organizations in the United States was the Philadelphia Society for the Promotion of Agriculture, founded in 1785. Philadelphia was then the capital of the new United States of America, and prominent leaders such as Thomas Jefferson, Benjamin Franklin, and George Washington were listed among the members of the society. The New York Society for the Promotion of Agriculture, Art and Manufactures was founded in 1791, and the Massachusetts Society for Promoting Agriculture was founded the following year.

As in other scientific societies of the time, library collections were a primary advantage of membership in agricultural societies. Not only were books, magazines, and newspapers collected, but members were often provided with lists of the items in the collection for their own reference. The founder of the New York society began its library the year the society was founded with copies of his book *Summary Views on the Course of Crops in Husbandry of England and Maryland* which had been published in 1784. George Washington contributed six volumes of the *Annals of Agriculture*. Fusonie (1988) noted that "the potential importance of agricultural society libraries was reflected in the 1794 proposal of the New York Society [that] . . . each County Society should be furnished with all the publications on agriculture in America . . ." (p.192). The Massachusetts Society began its library in 1797 and continued slowly to build the collection so that by 1815 it consisted of 125 volumes. Greathouse (1899) believed that these "probably included nearly all of the valuable books on agricultural knowledge in this country at that date" (p. 496).

In 1794, the Philadelphia Society discussed starting several additional agricultural libraries to be housed in schools in other parts of the state, but the plan was never implemented. The Massachusetts Society for Promoting Agriculture had a library by 1797. In 1793, the society had begun publishing information about agriculture in local journals, and an annual series of pamphlets was begun in 1795. These publications were exchanged with other societies in order to increase the size of the library collection (Greathouse, 1899).

Greathouse (1899) wrote that "In the South, the only agricultural society of this period...is that of the Winyah Indigo Society of Georgetown, South Carolina." Plantation owners founded the society in 1755 as a business and social organization, and a well-known library collection was provided for the members.

More specialized collections were begun in the next century. The Massachusetts Horticultural Society Library, which had been started in 1829, had an impressive collection of 10,000 volumes by the turn of the century. Today, its collection includes more than 29,000 books, 269 periodical subscriptions, and 24,000 prints (*American Library Directory*, 1988). Among its special collections are 35,000 trade nursery catalogs and a rare book collection that dates back to the fifteenth century. In 1963, G. K. Hall published a three-volume *Catalog of the Library of the Massachusetts Horticultural Society*. The library of the Pennsylvania Horticultural Society, founded in 1827, was smaller but still significant with more than 3,500 volumes by 1900. This library is still in existence. It includes volumes on eighteenth- and nineteenth-century horticulture among its special collections (*American Library Directory*, 1988).

In 1852, the United States Agricultural Society was founded. This group, in cooperation with various state societies, served as a lobby to encourage Congress to establish a department of agriculture. In addition to its lobbying activities, the society promoted the dissemination of agricultural information. Among its publications was a bibliography of the forty-five U. S. agricultural newspapers existing.

Blanchard (1977) noted that by the 1850s, in addition to libraries in agricultural societies, there were also libraries that had been started by the boards of agriculture of several states, including Massachusetts and Illinois. In the later years of the nineteenth century, farmers' reading clubs existed in Connecticut, Pennsylvania, Michigan, and New York. Greathouse (1899) noted that agricultural libraries for farmers also were sponsored by the granges and estimated that several hundred such libraries existed in 1899. Although their collections contained books of general interest in addition to those on agriculture, "they have proven effective in the promotion of scientific farming" (p. 511).

The Department of Agriculture Library

The Department of Agriculture Library originated with the Patent Act of 1790 which permitted the citizens of the new United States to protect their inventions. The Patent Office realized the need to refer to other patents as well as to scientific and technological literature, and a library was established. Henry L. Ellsworth, commissioner of the Patent Office, had urged that a library be authorized because "the necessity of a library of scientific works to facilitate the discharge of the duties of this office need only be mentioned to be duly appreciated (Fusonie, 1988, p. 194). Among the agricultural items housed in the Patent Office were seeds and specimen plants not found in the United States, and in 1831 the Patent Office began a seed distribution program. The need for agricultural information was so important in the Patent Office that a separate Agricultural Division was established in 1839 with its own library collection (Adkinson, 1978).

Although the collection of what is now the Department of Agriculture Library had its origins in the Agricultural Division of the Patent Office, the concept of such a library is even older. In 1796, while discussing the importance of agriculture, President George Washington proposed to Congress "the establishment of Boards, composed of proper characters, charged with collecting and diffusing information... to encourage and assist a spirit of discovery and improvement" (*Writings of George Washington,* 1940, XXV, p. 315).

It was sixty-five years before Washington's ideas were implemented. As the bureaucracy of the new government grew and changed, and the importance of agriculture became more clear, a Committee on Agriculture was established in 1820 by the House of Representatives. The Senate created a similar committee five years later. Finally, in 1861, President Abraham Lincoln proposed the establishment of the Agricultural and Statistical Bureau. The United States Agricultural Society, a privately supported group, lobbied to have an Agriculture Department created instead. In 1862, in the Organic Act, Congress authorized a separate Department of Agriculture with a commissioner who would be appointed by the President (Fusonie, 1988).

One of the original responsibilities of the Department of Agriculture is:

> to acquire and to diffuse among the people of the United States useful information on subjects connected with agriculture in the most general and comprehensive sense of that word. . . . The Secretary of Agriculture shall procure and preserve all information concerning agriculture which he can obtain by means of books and correspondence . . . ." (Shaw, 1948, p. 133)

This charge led to the development of a library for the Department of Agriculture under the direction of the Commissioner of Agriculture.

During the first year of its existence, $1,000 was authorized to buy books for the library. The collection of 1,000 volumes in the Agricultural Division of the Patent Office was transferred to the new Department of Agriculture library, and $4,000 was allocated for the library in 1864. The library had published a catalog of the Department of Agriculture's publications and was able to use this in 1866 to facilitate exchange programs with other agricultural organizations throughout the world. The program was quite successful, and Fusonie (1988) noted that: "Under the publication exchange program, an additional 1,000 volumes of valuable books and periodicals in such languages as German, French, Italian, Spanish, Danish, and Swedish were added to the library's collection" (p. 196). The collection had grown to 8,000 volumes by 1871, and Mohrhardt (1957) noted that "by 1898 was considered the most complete agricultural library in the world" (p. 63).

The library's significant growth was not always without difficulty. In his excellent "History of the National Agricultural Library," Fusonie (1988) notes that as late as 1892 "the library still lacked adequate financial support, proper facilities and appropriate personnel" (p. 198). Julius Sterling Morton, secretary of agriculture, sought to remedy the situation and wrote to Melvil Dewey in June 1893 asking him to develop a list of criteria to be used in selecting the next librarian of the Department of Agriculture. The examination, which was developed with Dewey's input, included sections on "orthography, penmanship, letter writing, elements of the English language, arithmetic, modern language, library economy, bibliography, and literature of agriculture" (Fusonie, 1988, p. 198).

William P. Cutter, who was selected to be librarian under the new criteria, made many changes to improve the library's collection and the organization of information. At this time, the collection consisted of some 38,000 books, more than half of which were housed in divisional libraries. Under Cutter, most of the collection was consolidated in a central location. A dictionary catalog was begun, additional funds were used to complete serial runs, and a new reading room was opened. In the words of the Secretary of Agriculture, "the library has been made in this manner a working laboratory instead of a miscellaneous storehouse" (Fusonie, 1988, p. 199).

In spite of Cutter's efforts to consolidate the collection, a number of independent agency libraries existed within the Department of Agriculture, beginning in 1920. More than forty bureau libraries included those of the Forest Service, the Weather Bureau, Agricultural Engineering, Biological Survey, and Chemistry and Soils. Their collections had been purchased and cataloged by the main library, but the staffs were paid by the bureaus. There was duplication of collections and services, as there often is in decentralized library services, but, in spite of this, many department employees in the field had no library service. The bureau libraries that had been established in the first years of the twentieth century were consolidated in 1942 during the first months of World War II. This was done in part to avoid further unnecessary duplication of services and in part because of space shortages in Washington during the war. Both staff and collections were transferred from the bureau libraries to the Department of Agriculture Library during the centralization.

Various directors of the library have been aware of the importance of cooperation with other libraries. As early as 1900 the library loaned its holdings to other libraries. Shaw (1948) observed that although the library had been authorized to sell catalog cards in 1899, it stopped offering this service in 1906 and instead provided cataloging copy to the Library of Congress. The library also cooperated with the Army Medical Library in collecting items of historical interest and relied upon them for medical information. In 1915, Library Director Claribel Barnett wrote that she wanted to expand the library's services further by enhancing relations with academic and experiment station libraries. When funding has been available, such outreach services have been provided (Blanchard, 1977, p. 228). Thomas explained in 1989: "Informal networking has been a tradition in the agricultural information community. In the last five years, however, the National Agricultural Library (NAL) has worked assiduously to bring a formal organization into being" (p. 113). The United States Agricultural Information Network (USAIN), with representatives from all aspects of agricultural librarianship, provides a cooperative forum for discussion of agricultural information issues.

The library has also been involved in developing international cooperation among agricultural libraries. Director Foster Mohrhardt was one of the leaders who formed the International Association of Agricultural Librarians and Documentalists. The library has also worked with the Food and Agriculture Organization (FAO) of the United Nations to develop the International Information System for Agricultural Sciences and Technology (AGRIS). The FAO's David Lumin Memorial Library in Rome is the site for the Agricultural Libraries Network (AGLINET) which works with the National Agricultural Library and other major libraries to improve document delivery among agricultural libraries around the world. The librarian for the FAO Fisheries Branch Library, for example, has consulted with other libraries and has established exchange programs in Malaysia, Thailand, India, Pakistan, and the Philippines (Cuerden, 1988).

Bibliographies on specific subjects have been produced by the library for most of this century, but, in 1942, the comprehensive index, *Bibliography of Agriculture,* was begun to provide access to the journal literature. The *Dictionary Catalog of the National Agricultural Library, 1862-1965* and the *National Agricultural Library Catalog* provided information about the rest of the collection. The catalog was last published in December 1985, when users were encouraged to make use of online access to the library's holdings through the OCLC database instead of the printed catalog.

The Department of Agriculture Library has frequently been a leader in the application of technology to libraries. For example, in the late nineteenth century, William Cutter replaced the gas lamps in the library with incandescent lamps. In 1934, Claribel Barnett introduced the Bibliofilm Service, which provided microfilm copies instead of lending the original documents. The Bibliofilm Service was developed with the cooperation of the American Documentation Institute and Science Service and was an immediate success. In the first year, more than 300,000 pages of microfilm copy were distributed. A decade later, Ralph Shaw introduced inexpensive copies using a new photocopying machine that used a continuous roll of paper rather than single sheets. Further advances in the application of microfilm technology to libraries were also made under Shaw's direction.

In 1970, magnetic tape records were introduced to replace manual reproduction of the *Bibliography of Agriculture.* Online access to the *Bibliography of Agriculture* has been available through the AGRICOLA database. Compact Disc-Read Only Memory (CD-ROM) has been used at NAL since 1988 to provide alternative, faster, and less expensive access to the AGRICOLA database. In recent years, the library has become a leader in utilizing optical disc storage technology in libraries. Andre (1989) described the experimental projects to provide simultaneous access to both full text and graphics of the *Pork Industry Handbook* in 1985. Another project included visual materials from the Forest

Service Photographic Collection on video disc. Interactive laser disc technology has been used to produce an educational program on the AGRICOLA database. Software has been utilized to develop expert systems in specialty areas such as aquaculture information.

The National Agricultural Library

In 1962, the 100th anniversary of the establishment of the U. S. Department of Agriculture, the library was designated the National Agricultural Library (NAL), one of three national libraries in the United States. The library, which had been located in Washington, D.C., moved to new facilities near the Agricultural Research Center in Beltsville, Maryland, in 1969. The location permitted the library to offer enhanced services to the researchers at the Agricultural Research Center, while maintaining services to the other staff of the department in the Washington area.

The library is fifteen stories tall and houses a collection of 2 million volumes including more than 25,000 journal titles. The NAL Collection Development Policy states that:

> The focus of collection development at NAL is on acquiring information important for the advance of agriculture regardless of its source, language, medium or form. The Library is collecting machine-readable materials, audiovisual material, juvenile literature, and other sources of information relevant to agriculture.... (1988, preface)

One copy of each of the agriculture books received by the Copyright Office of the Library of Congress was sent to NAL in the past (Blanchard, 1977) although this is no longer the practice. In 1970, a law was passed which gave NAL "the authority to accept books, manuscripts, and other important agricultural memorabilia" (Fusonie, 1988, p. 206) to add to the collections.

Among the special collections that have been developed are an extensive historic collection which includes rare books, manuscripts, oral history transcripts, and trade catalogs. The Nursery and Seed Trade Catalogs Collection was begun in 1904 to "provide information regarding sources, prices, descriptions of plant material offered for sale" (*Our Agricultural Heritage*, p. 5) and includes some items that were published as early as 1771. The Forest Service collection of photographs is the largest collection of its kind in the world. More than 13,000 maps in another collection provide information about soil classification; national forests; land use; annual precipitation; vegetation; distribution of insects; plant, and animal diseases; and transportation. A collection of posters on special topics, such as the role of agriculture during the first World War or the development of insect control, are of value to historians.

The National Agricultural Library provides information to all sectors of the agricultural community. It receives more than 180,000 requests for documents every year with an additional 30,000 requests for information. Information centers within NAL have been established to provide literature searches and specialized services in areas such as alternative farming, animal welfare, aquaculture, biotechnology, critical materials, food irradiation, and food and nutrition.

The Librarians of the Department of Agriculture

Aaron Burt Grosh, one of the founders of the National Grange and a clergyman, was the first librarian for the U.S. Department of Agriculture. He was followed by Stuart Eldridge (1869-71), John B. Russell (1871-77), and Ernestine H. Stevens (1877-93). William Parker Cutter (1893-1901), who was selected under Melvil Dewey's criteria, reorganized the library and introduced professional policies and procedures. He was followed by Josephine A. Clark (1901-07), a botanist who had served as Cutter's assistant librarian. Claribel R. Barnett (1907-40), introduced the Bibliofilm Service in 1934. Ralph R. Shaw (1940-54) introduced the technological advances of that time to the library. Under his direction, the library began publication of the *Bibliography of Agriculture* in 1942. Foster E. Mohrhardt (1954-68) was a founder of the International Association of Agricultural Librarians and Documentalists while he was librarian, and John Sherrod (1968-73) supervised the construction of the library's new facilities and the introduction of computers to the library (Moran, 1976; Bercow, 1962). Richard A. Farley served from 1974 to 1983. During these years the library "continued to make advances in size, research importance, and world-wide access to its collection" (Fusonie, 1988, p. 205). The present director, Joseph Howard, came to the National Agricultural Library in 1983 from the Library of Congress and has strengthened the library's national and international role with expanded services and the application of contemporary technology to both the management and the use of agricultural information.

Other Government Agricultural Libraries

In 1938, four regional research laboratories were established under the Secretary of Agriculture to develop new agricultural chemicals and products and to find new markets for agricultural commodities. The sites selected for these laboratories were Philadelphia, Pennsylvania; Peoria, Illinois; New Orleans, Louisiana; and Albany, California. Library services were included in the initial planning of these sites. Beckmeyer (1947) noted that, in addition to more traditional collections of monographs, pamphlets, and serials, the library at the Southern Regional Laboratory developed an index to agricultural patents. At the library of the Northern Regional Research Laboratory in Peoria, Illinois, Nellie Larson (1953) observed that she was "responsible for maintaining a working collection of currently useful publications only and no obsolete, superseded or little used materials are retained" (p. 453).

In 1942, the Department of Agriculture extended service into the field through regional libraries. Regional branch libraries were established in Upper Darby, Pennsylvania; Little Rock, Arkansas; Atlanta, Georgia; Lincoln, Nebraska; Albuquerque, New Mexico; Fort Worth, Texas; San Francisco, California; and Portland, Oregon. The need for such libraries was explained by Mildred B. Williams (1941), chief, Division of Field Library Service: "Five out of every six Department employees are stationed in the field, the majority without library service through official channels" (p. 550). Core collections of standard reference sources were provided in all libraries, but each collection also was specialized to reflect the topics of interest to that region. Copies of the publications of the staff in that region, local farm journals, and experiment and extension publications were expected to be collected as well. Sub-branch libraries provided more limited services (Buhler, 1942; Mohrhardt, 1957).

The Forest Service, which had been the Bureau of Forestry, became a separate agency of the Department of Agriculture in 1905. Regional experiment stations in Utah, Minnesota, Pennsylvania, Arkansas, California, Colorado, and Louisiana each have libraries, some of which date from the 1920s. The library of the Pacific Southwest Forest and Range Experiment Station in Berkeley, California, has a staff of twelve including five professional librarians and a collection of more than 32,000 volumes. The Forest Products Laboratory Library in Madison, Wisconsin, was founded in 1910. Its current collection of more than 56,000 books and 30,000 technical reports includes a special collection on forest product utilization.

There are several libraries serving the U.S. Fish and Wildlife Service as well. The oldest is at the Abernathy Salmon Cultural Development Center in Longview, Washington, and was established in 1942. Its collection of 125 books and 175 periodical volumes focuses on fish culture, hatchery techniques, and water reuse. The Technical Information Services at the National Fisheries Center in Kearneysville, West Virginia, was started in 1959 and has more than 25,000 books and 790 periodical subscriptions with particular strengths in the area of aquaculture, chemotherapy, and freshwater biology. Special collections include 16,000 reprints on fish diseases and 8,000 reports on fish culture. The library serves as a clearinghouse for all Fish & Wildlife Service aquacultural materials (*Directory of Special Libraries,* 1985).

In addition to the many agricultural libraries that serve the U.S. government, there are also similar libraries at the state level. Greathouse wrote in 1899 that the library of the Massachusetts Board of Agriculture, which was started when the board was established in 1852, was considered by 1857 to be "the most extensive in the United States" (p. 504). The Illinois State Board of Agriculture library was started in 1853 and by 1899 had 5,000 volumes of which the livestock records were the most heavily used. Unfortunately, neither of these libraries seem to be in existence today.

Schmidt (1980) noted that special libraries are frequently started because of an individual or event and describes the library of the Minnesota Department of Agriculture as an example. Materials that had been housed in several offices and other locations were brought together in 1980 when the department was relocated. A professional librarian was given ten weeks to centralize the collection and to train a secretary who would continue to manage the library. Like most such libraries, this collection is still very small with a concise reference collection. Minnesota contracted with the Professional Library of the State Department of Education to provide reference services including online searches, a service that has been appreciated by the users.

The Texas Department of Agriculture Library was started in 1974 as one shelf of press releases and clippings. As in Minnesota, it was when the department moved to a new building in 1975 that materials from several locations were brought together. Crosswell (1985) noted that the library now consists of more than 3,000 books and has been cataloged. An extensive vertical file and subscriptions to 130 newsletters augment the collection.

Academic Agricultural Libraries

Libraries in academic institutions were among the earliest to support collections of agricultural information. Greathouse (1899) listed the books included in the agricultural section of the Harvard library catalog in 1790. Although only sixteen titles are listed, Greathouse stated that "there were undoubtedly in the total of 12,000 volumes many treatises on botany, chemistry, entomology, and geography which were valuable to the occasional student of farm problems" (p. 495).

Agricultural education had been offered by New York state as early as 1819 at Ovid Academy, but it was not until 1857 that the first agricultural college was established in Michigan. This institution is now known as Michigan State University. Pennsylvania, Maryland, Iowa, and Minnesota also began agricultural colleges in the next two years. The demand for agricultural education throughout the United States increased, and, in 1857, Justin S. Morrill, representative from Vermont, introduced the Federal Land Grant Act. The measure, sometimes referred to as the Morrill Act, was finally passed in 1862. This legislation provided 30,000 acres of land to each state for each Senator and Congressman representing it. The state was to sell the land and use the income to establish an agricultural and mechanical college. The majority of states established new colleges while some states chose to use the funds for new departments of agriculture in existing colleges. In 1890 a second bill was passed which provided regular allotments of federal funds to each of the land-grant colleges and included funding for historically black colleges of agriculture.

Thurber (1945) observed that "the founders of the agricultural colleges considered books and libraries as indispensable requisites of an educational institution. It was their desire that the libraries be the chief attraction for all the better class of students" (p. 347). Collections were to include classic works as well as contemporary writings, and the library was to provide appropriate facilities for study and writing. In spite of these plans, many libraries in land-grant institutions were underfunded. In order to stretch their limited budgets, the libraries became depositories of federal documents and established programs to exchange their own publications among themselves. The reports of the land-grant institutions in several states in the 1870s and 1880s included statements about the need for additional funds for collections and preservation of existing materials. Gifts, such as $150,000 to the University of Vermont and $50,000 to Rutgers College, permitted new libraries to be built.

Many of the land-grant college libraries in the eastern United States were helped in their early days by receiving sizable portions of the state agricultural society libraries. With this assistance and with other support, by 1899, Michigan Agricultural College had acquired more than 9,000 agricultural publications, and Rutgers College had more than 12,000. Not all libraries grew as quickly, especially in the west. The Utah Agricultural College had only 364 books on agriculture in 1899. Sometimes creative means were used to add to library collections. A professor at Cornell University arranged for an endowment funded by beekeepers who donated the revenue from one bee colony per year. "When contributions from one co-operator have reached $50, each year thereafter one book will be purchased from the endowment fund and inscribed with the name of the donor" (Colcord, 1926, p. 139).

McCarthy (1948) surveyed the fifty-two land-grant colleges and universities and found that the agricultural college library was usually part of the main library. When there was a branch library for agriculture, as there were on twenty-five of the campuses, the main library was usually responsible for acquiring, binding, and cataloging the agricultural publications, and the holdings of the branch collection were then included in the main card catalog. McCarthy calculated library expenditures per student in land-grant institutions and found that they varied widely from campus to campus although there had been steady increases in the average expenditures during the previous two decades.

Experiment Station Libraries

Overfield (1986) noted that prior to 1880 there was "little science that was directly applicable to agriculture" (p. 268), and the research efforts from 1880 to 1920 were successful in changing the nature of agriculture. The need for scientific research about agriculture led to the establishment of agricultural experiment stations in some states. In Europe, some experiment stations were established as early as 1834. In the United States, the first such facility was the Connecticut Agricultural Experiment Station in New Haven, which was founded in 1875. Unlike most later experiment stations, this facility is not part of a college of agriculture. The original research was limited to plants and soils, and the original library collections reflected these topics. The Osborne Library, named for Thomas B. Osborne who donated his 3,500 volume collection of rare chemical journals to the library in 1925, now has a collection of more than 23,000 volumes. Giandonato (1947) described additional departmental libraries in the various buildings at the station where secretaries managed reprints and binding.

Other states followed Connecticut in establishing agricultural experiment stations and, subsequently, libraries. By 1882, North Carolina's station had a library with fifty volumes, while in the same year the station in Geneva, New York, cited twenty-three titles in its first annual report. Six years later the need for funds for a reference library at the Geneva experiment station was stated in the annual report, a need that was reiterated in 1899: "A good library is a most necessary part of experiment station equipment. Research can neither be entered upon safely nor its results discussed intelligently unless the investigator has access to the records of what has been learned previously concerning the subjects under consideration" (Giandonato, 1947, p. 354).

In 1887, the Hatch Act authorized federal funds for the establishment of agricultural experiment stations in conjunction with the land-grant institutions to conduct agricultural research. The $15,000 that was provided annually by the federal government was used by those states that already had experiment stations to increase the amount of research that was supported. Other states, especially those in the west, used the funds to establish experiment stations for the first time, and, by 1900, there were experiment stations in all states and territories. The library collections that existed at experiment stations were often small. The funds for libraries in experiment stations were sometimes combined with the funds for academic libraries in land-grant institutions to provide a single, stronger collection (Overfield, 1986).

The value of agricultural experiment station libraries to the individual station was explained in 1911 by E. H. Jenkins, the second director of the Connecticut station, when he spoke to the Association of American Agricultural Colleges and Experiment Stations. Giandonato (1947) quotes Jenkins as noting that:

> A station library, as distinct from a college or university, must chiefly contain strictly technical treatises and journals, because it should be solely for the use of persons engaged in agricultural research and experiment....We are not, therefore, likely to find any single station library which is equally full or equally well selected in all departments...nor shall we be likely to find any two libraries which are alike. (p. 357)

Towne (1933) surveyed agricultural experiment stations in 1932 to determine the status of their libraries. Of the forty-three stations that responded, thirty-seven were spending funds for books and/or periodicals, while only six included library services in their budgets. The majority of the experiment station libraries (twenty-five) were located on a college campus but separate from the main library. Fourteen of the libraries were administratively independent of the academic library. Blanchard (1977) hypothesized that if a survey were conducted now "it would probably indicate an increase in centralization with much more service being provided exclusively by the main library or one of its branches" (p. 231).

Corporate Agricultural Libraries

While most other types of agricultural libraries can trace their histories to the nineteenth century, libraries in corporations dealing with agriculture are primarily an innovation of the mid-twentieth century. An article on "Agricultural Library Work," published in 1926, did not even mention corporate libraries. As an example, the J. W. Cummins Memorial Library of Farmland Industries, a manufacturing company in Kansas City, Missouri, was not begun until 1950, although the company was started in 1929. The main library collection at Farmland Industries consists of agriculture and economics, and also includes the history and records of the company. Branch libraries for technology and training are located at other corporate sites (Hudson, 1981).

The Illinois Agricultural Association library was not started until 1957. The staff of eight provides service to the almost 3,000 employees throughout the state. Although all employees may use the library, the staff in research, marketing, publications, and legislation are the most frequent users. FARMBLISS, an in-house computer system, is used for serials control and generation of routing slips (Olson, 1980).

Conclusion

During the last two centuries, agricultural libraries in the United States have grown from comprehensive collections consisting of 125 volumes to comprehensive collections of more than 2 million volumes. The number of agricultural libraries has tripled in this century, and new libraries serving agricultural corporations have emerged. The efforts of generations of librarians have brought about bibliographic control of the literature, opportunities for resource sharing, and new applications of technology.

Ninety years ago, Charles H. Greathouse (1899) wrote about the development of agricultural libraries. He noted that "the farmer has constantly found himself wanting information on one subject and his book or paper offering him information on another....His need is a library within reach that will furnish in concise form the entire body of thoroughly proved agricultural science" (p. 491). Although very few libraries have approached Greathouse's ideal of a collection encompassing the entire body of agricultural information, the number and variety of agricultural libraries today are providing more information to more users than could have been imagined in the nineteenth century. Recent advances in applications of technology may actually put the ideal library within reach of the individual farmer of the twenty-first century.

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Management of Trends in Agricultural Libraries

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ABSTRACT

THIS ARTICLE REVIEWS in a broad way, agricultural library trends of our time. Although a number of trends could have been selected, those included here were chosen for their deep and permanent impact on agricultural libraries. They have considerable significance for change in U.S. agricultural libraries and, therefore, for their management.

THE PURPOSE OF U.S. AGRICULTURAL RESEARCH LIBRARIES

> unless the basic concepts on which a business has been built are visible, clearly understood, and explicitly expressed, the business enterprise is at the mercy of events. Not understanding what it is, what it represents, and what its basic concepts, values, policies, and beliefs are, it cannot rationally change itself. (Drucker, 1973, p. 75)

U.S. agricultural research libraries have been built within the concepts of the land-grant university system. These concepts are put forth in the public laws of the United States:

> That the moneys *(from the sale of the grants of land given to the States by the Federal Government)*...be appropriated to support and maintenance of at least one college where the leading object shall be without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts...in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life. (Public Laws of the United States, 1862)

In practice, the land-grant university was to be explicitly anti-elitist. It was, first, to provide instruction, including the classics, to "ordinary" people; second, to extend its knowledge base to those who

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could not qualify as students in the classrooms; and third, to make all human endeavors legitimate subject matter for scientific investigation and scholarship. Prior to the emergence of the land-grant concept in 1862, acceptable scholarship was largely confined to theology, history, arts and letters, law, and, from Germany, medicine. "The land-grants were to be better than Harvard and Yale under the values of democratic America" (McDowell, 1988). Throughout their history the land-grant colleges and universities:

> have emphasized the dignity of labor, the combination of liberal and practical education, social consciousness, a widening opportunity in the democratization of education, the potentiality of science, the freedom of education through secular control, the necessity for citizenship training, the regard for the student and citizen as individual, and the idea of a university serving all the people throughout their lives. (Eddy, 1956, p. 286)

The structure used to carry out the land-grant mission has three components: instruction, legislated by the Morrill Act of 1862; research, legislated by the Hatch Act of 1887; and extension, given recognition by the Smith-Lever Act of 1914. An additional important event in land-grant history was the Second Morrill Act (1890) which legislated not only an annual appropriation to land-grant colleges, but also the equitable division of the annual appropriations between white and black students. The act thus inspired and encouraged the establishment of a number of 1890 land-grant colleges throughout the South.

The libraries built to support this new democratic scholarship were bound to the same concept of anti-elitism as their parent institutions. Theirs is the responsibility for organizing and providing free access to the records of scholarship not only in the classics, but particularly in science applied to agriculture and to peoples' farm and home problems. This responsibility is unique to the land-grant university library. It is sometimes carried out by integrating the scholarly literature of the agricultural sciences, the life sciences, and the related social sciences with the literature of the other broad areas of knowledge—as at Michigan State University and Iowa State University—and sometimes by establishing a separate collection, building, and services—as at the Mann Library at Cornell University and the Steenbock Memorial Library at the University of Wisconsin-Madison. Either way, the responsibility is to serve as the U.S. agricultural research libraries.

The libraries hold sacred as their purpose, collecting and providing free access to the scholarly record by the people, about the people, for the people. Expressed differently, the collections of the land-grant libraries contain records of applied and basic research in the agricultural, life, and related social sciences. These collections support research, classroom instruction, extension service, and free use by all citizens of this nation.

In this responsibility, land-grant university libraries are joined by the National Agricultural Library (NAL) and its system of field libraries, an arm of the U.S. Department of Agriculture (USDA). The collaboration of the USDA and the land-grant universities is a matter of record, having its beginnings in the Adams Act of 1906. Generally, the basis for cooperation has been that the land-grants are concerned with the varying needs of their respective states, and the USDA's concern is with matters at the national level. It is generally conceded that, although the problem of relationship has not been easily solved, over the years the cooperation has proved productive.

TRENDS IN U.S. AGRICULTURAL LIBRARIES

Toward a New Paradigm of Librarianship

Forty years ago a technological revolution took place when the first ENIAC (Electronic Numerical Integrator and Calculator) was turned on. Built at the University of Pennsylvania, its cabinets were nine feet high and weighed thirty tons. It occupied the space of a small gymnasium, was fickle in its performance, and used so much electricity, it is said, that "the lights of Philadelphia dimmed when the ENIAC was turned on" (Forester, 1987). But it was the first revolutionary electronic digital computer capable of performing thousands of calculations per minute.

Today, the United States is being revolutionized by the impact of powerful computers and telecommunications. The driving force of the technology is its power to generate types of information which heretofore have been unthinkable, store information in small spaces, retrieve and manipulate it with dazzling speed, and transmit it to a distant location within seconds.

This high technology is producing a society in which information, or knowledge capital, is emerging as a key economic resource. In its report, *Global Competition: The New Reality* (1985), the President's Commission on Industrial Competitiveness concluded that success in international trade strongly depends on science, technology, and the control of information. Brandin and Harrison (1987) in their book *The Technology War* say:

> The Technology War is about the worldwide race to capture the lead in the strategic technology: information technology. Those that prevail in this war will control the resources of the world; they will control their Lebensraum; they will be the next global powers....Information wealth is becoming a new type of capital known as knowledge capital. (p. v)

In short, those with access to, and control of, information will be the power brokers of the future. They will possess information capital, the new strategic commodity. If any nation is to remain internationally competitive in the information age, it must concern itself with developing in its citizens, scholars, and leaders the capability of managing and using information.

This is not a new concept in the United States; it was the very reason for the establishment of the land-grant university. The need for the people to have access to information was seen as the essence of a democracy. Access to information, however, has been based in the print tradition and, today, information is produced increasingly by the computer, stored in electronic form, and distributed via telecommunications. The technology has infused information with a new power and a new level of significance. Information has become a strategic commodity in the global economy. The Japanese and European governments, and a host of other nations, have perceived the need for a competitive edge in information technology. The need of the people to exploit information is still a matter of supporting a democratic way of life, but today it is also at the heart of any nation's ability to remain as a competitor in the global economy. As we move toward the twenty-first century, we will have to shift perceptions and abilities from information in traditional print format to information in electronic form.

Within land-grant universities, librarians, traditional custodians of scholarly information, are faced with an anomaly. Information is being generated in electronic form. The model of theories, practices, and standards used to provide access to knowledge has been based in the print tradition; librarians will have to adopt new theories and practices for providing users with electronic information. A new paradigm is needed. Thomas Kuhn's (1970) conceptual framework of paradigms would suggest that the profession is experiencing a paradigm shift.

In particular, land-grant libraries of the United States have a special responsibility of assuring access to knowledge for scholarly users, and for ordinary people seeking solutions to their problems at work and home. Libraries do not have the option of saying that their mission is to provide access to the records of civilization—as long as those records are in print form. And yet they have. Historically, universities, using computer files, have created data archives to store magnetic tapes and data documentation. The archivist consults the user who needs the data and then extracts the desired subset. Other machine-readable forms of information have been acquired and held by computing centers because of their experience with systems needed to access the data. In both arrangements a precedent was set; machine-readable information was different from print and libraries as a rule did not handle it.

Initially, databases often duplicated print sources, but, increasingly, machine-readable sources have become the unique medium for information. As long as data remained available in both print and electronic form, use of computerized data was a matter of preference. Now that critical sources of research data appear only in electronic formats, use of the computer for access to research information has become a necessity.

In the agricultural and biological area, database growth is tremendous and might well be leading other scientific disciplines. For example, several agencies within the USDA, including the Crop Reporting Board, the Economic Research Service, and the Foreign Agricultural Service, generate and sell data on floppy diskettes and magnetic tape. The department releases data concerning volatile prices, online, through the EDI system of the Martin Marietta Company. The Department of the Interior's Fish and Wildlife Service, as well as the Bureau of Land Management, generates habitat and ecological data in electronic form. The National Library of Medicine and the Department of Energy co-sponsor a compilation of genetic sequences which is processed on a computer at the Los Alamos National Laboratory and then released to the public through a private contractor (IntelliGenetics) as the *GenBank* database. At the international level, the United Nations' Food and Agriculture Organization (FAO) issues several types of data on magnetic tape, including production and trade statistics.

The application of computer and telecommunications technology to research information changes the means of storage and the mode of access to research data. However, it does not change the mission of the land-grant library. In the future, these libraries will have no alternative but to collect major portions of the records of scholarship in electronic form. The real issues, then, are how libraries can make the transition to the electronic storage and dissemination of research data effectively, and how they can best serve patrons with new information technologies. The operating premise is that scholarly information in electronic format must be incorporated seamlessly into the library's collection.

The scenario for which the library is responsible is that of users at workstations (where workstation is each user's microcomputer) accessing data and the full-text of literature regardless of their location, and downloading, manipulating, and integrating pertinent segments into personal databases. The locus for the user's access to scholarly information will be outside the four walls of the library—i.e., in offices, laboratories, and homes. The library must also ensure that a wide variety of resources is accessible, that their availability is publicized to users in an intelligible way, that the data resources are usable, that the user's workstation can perform certain functions well, and that the telecommunications systems have sufficient bandwidths to support the sharing of information resources among institutions across the state, the nation, and the world. Implementing the electronic library requires focusing on users at their workstations.

Today these users are all busy with a variety of activities at their workstations. If, for example, the user is an extension agent, he or she may be using files of extension news and activities, sending electronic mail, reading bulletin boards, using county and city data online, or downloading parts of a file on pest management to pass on to the farmer. If, however, the user is an instructor, he or she may be using the workstation to create courseware to be loaded onto a local area network for use by students, or searching a bibliographic database to update class reading lists, or creating a database of student profiles from an administrative information file. If the user is a researcher, he or she may be checking a new gene sequence in the GenBank on the local mainframe, or running a SAS program to analyze data, or downloading citations and abstracts into a personal bibliographic file, or sending the latest version of a manuscript to a colleague, or simply managing grant funds.

What these users have in common is the fact that these activities are handled by computers and telecommunications. Often, however, the activities are being carried out by individuals independently of each other which results in duplication of resources and a lack of compatability of hardware, software, and networks. It is essential that users at their workstations be supported by a systematic order of things.

In this electronic world of the user, it is clear that the electronic library will be but one component and this component cannot be planned and provided separately from the total information processing environment of the users. Overall, the system of hardware, software, and communications networks needs to:

—link county extension offices, campus faculty, and administrative units to each other and to national and international networks;
—accommodate a variety of tasks carried out by faculty, students, staff, administrators, and extension agents;
—support the systematic organization of, and access to, bibliographic, numeric, demographic, and full-text databases for online access;
—permit the sharing of information resources across the state and national networks;
—support the storage and transmission of administrative information;
—support workstations with adequate speed, storage, and resolution for a variety of information activities including use of audio and graphics;
—provide a user interface which is "intuitive, consistent and standard... in which the user has illusion of total control...the response time is always fantastic." (King, 1988, p. 164)

In conclusion, some illustrations of the effects of the computer technology revolution are offered—Mann Library at Cornell University was the site for the case study.

—Staff throughout the library depend on the smooth functioning of a technical infrastructure of workstations, networks, large computers, and software for the performance of daily work and for the delivery of essential library services.
—Reference staff include a computer files librarian, an interface and database designer, a computing statistician, two programmers, and three information literacy specialists.
—All staff handle electronic information, but 50 percent of the staff are predominantly responsible for electronic information.
—All staff members attend workshops on such topics as campus mainframes, the library's computing environment, SAS, and dBase.
—Research and development projects in the library explore applications of emerging information technologies in the control and delivery of scholarly information in electronic form.

—Recent advances in mass storage and display technology are used for the control and delivery of electronic full-text with graphics.
—Catalogers question the constraints of the MARC record for an online environment and information in electronic form; a cataloger's job description requires knowledge of the principles of relational databases.

Toward a Crisis in Publishing

More Money for Less of the Publishing. Libraries, generally, are in an era of spending increased amounts of money to collect a decreasing proportion of the scholarly record. This is felt particularly strongly by science and technology libraries. For example, in Cornell University's Mann Library which collects materials in the agricultural, biological, nutritional, and related social sciences, the acquisitions expenditures have increased 523 percent since 1970/71, but the cost of journals in these subject areas has increased by over 647 percent.

The phenomenon of spiraling journal costs, particularly in science and technology, is well documented. In particular, an ARL commissioned study on serial prices and costs provides a good exposé (Association of Research Libraries [ARL], 1989).

It is helpful in examining the nature of this trend to again use Mann Library as a case study. As a major research library in agriculture, biology, and the social sciences, Mann's buying power for journals has been affected by fluctuations in currency exchange rates, extraordinary price increases, and a phenomenal increase in the number of scientific journals.

About 48 percent of Mann Library's serials expenditures are for foreign journals. Price increases of greater than 20 percent were quite common in the period 1985-87. Fluctuations in the currency exchange rate are responsible for much of the decrease in buying power. Some key examples are provided in Table 1.

The net change in buying power of the U.S. dollar from 1970 to 1988 (March) ranges from -36.9 percent against the British pound to -84 percent against the French franc. The effect is exacerbated as the importance of European commercial journal publishers has increased over the last two decades.

Another effect on buying power is the increase in scientic journal prices. The subject areas in which Mann Library collects are among the most expensive and have been subject to the highest price increases. Table 2 ranks twenty-six subject categories by average price per journal title. The bulk of Mann's acquisitions dollars are spent in the categories "zoology" and "mathematics," etc. (which includes plant science, geology, and general science) which in terms of expense also rank third and fourth respectively.

Table 3 shows an annual rate of price increase for biology journals of 13.5 percent, the highest in the sciences. Since 1971, Mann Library has

TABLE 1
FOREIGN EXCHANGE RATES
1970-1987
(IN U.S. CENTS PER UNIT OF FOREIGN CURRENCY)

	Year	*Austria (schilling)*	*France (franc)*	*Germany F.R. (deutsche mark)*	*Japan (yen)*	*Netherlands (guilder)*	*Switz (franc)*	*UK (pound)*
	1970	3.87	18.09	27.42	0.28	27.65	23.21	239.51
	1975	5.75	23.35	40.73	0.34	39.63	38.74	222.16
	1980	7.73	23.69	55.09	0.44	50.37	59.71	232.58
	1985	4.88	11.23	37.27	0.42	30.39	41.14	129.74
June	1986	6.21	13.95	43.62	0.56	38.69	52.15	147.58
March	1987	7.75	16.52	55.01	0.66	48.69	65.75	161.82
March	1988	8.46	17.52	59.31	0.77	52.81	71.84	177.71
Value of U.S. dollar 1985-1988		-73%	-84%	-59%	-83%	-74%	-75%	-36.9%

Sources: 1970-1985, *U.S. Statistical Abstract.* Figures are annual averages (except 1986).
March 1987 and March 1988, *Wall Street Journal.*

TABLE 2
AMERICAN LIBRARY ASSOCIATION
LIBRARY MATERIALS PRICE INDEX COMMITTEE
SUBJECT CATEGORIES IN RANK ORDER

	Category	*1988*	*Rank (88)*	*Rank (72)*
	Soviet Translations	$592.22	*	*
1	Chemistry and physics	$329.99	1	1
2	Medicine	$180.67	2	2
3	Mathematics, etc.	$159.33	3	3
4	Zoology	$127.33	4	4
5	Engineering	$114.83	5	6
6	U.S. including Soviet	$105.45	6	8
7	Psychology	$100.57	7	5
8	U.S. overall	$77.93	8	7
9	Sociology and anthropology	$64.27	9	16
10	Home Economics	$54.73	10	10
11	Business and economics	$53.89	11	11
12	Journalism	$53.39	12	18
13	Library Science	$51.61	13	14
14	Education	$47.95	14	13
15	Industrial arts	$44.20	15	17
16	Labor and industrial relations	$44.06	16	25
17	Law	$43.33	17	9
18	Political science	$41.55	18	19
19	Agriculture	$33.56	19	24
20	Fine and applied arts	$32.43	20	20
21	History	$30.16	21	21
22	Physical education	$28.60	22	15
23	General	$28.29	23	12
24	Literature and language	$28.04	24	22
25	Philosophy and religion	$27.09	25	23
26	Childrens	$16.39	26	26

*Not separately indexed in 1972.
Sources: 1972 Brown, N. B. (1972). Price indexes for 1972: U.S. periodicals and serial services. *Library Journal, 97*(3), 2355-2357.
1988 Knapp, L. C., & Lenzini, R. T. (1988). Price index for 1988: U.S. periodicals, *Library Journal, 113*(7), 35-41.

tracked price increases of a representative sample or "market basket" of biological sciences journals. Table 4 shows these data. Mann's response to the problem of journal prices has been classic—i.e., cancel subscriptions, reduce expenditures on books, and devote a larger portion of the budget to serials, forego new subscriptions, except for the most essential purchases, increase the budget. Figure 1 provides a graphic indication of the degree to which research libraries are shifting acquisitions expenditures into serials subscriptions. This table and the accompanying explanatory text is from the ARL report cited in Table 3.

As a science library, Mann allocates a much larger proportion of its acquisitions budget to serials than to monographs. The highest proportion in recent years was 74 percent. Over the past four years it has gone up from 60 percent to 67 percent and will probably continue to climb under present conditions.

TABLE 3
ANNUAL RATE OF INCREASE
SCIENTIFIC JOURNALS

Academic Field	*Percentage of Increase*
Physical science	12.6
Technology	11.4
Medical	11.8
Earth science	12.1
Biology	13.5

Source: Association of Research Libraries. (1989). *Report of the Association of Research Libraries project on serials prices.* Washington, DC: ARL.

Mann's buying power has also been affected by the number of journals available. It has been estimated that there are currently over 100,000 science and technology journals published worldwide and that number increases by 2 percent annually. Commercial publishers in particular have taken to a practice called "twigging." This is the creation of new journals which deal with increasingly specialized narrow subdivisions of a subject area. These tend to spring up in the "hot" areas of science and have been a successful tactic in increasing market share in high impact science disciplines. This is at least partially driven by a problem in the system of scholarly communication and reward. To secure tenure and grants, academics are under pressure to publish—over 1 million articles in science and technology are published each year. Authors are demanding more outlets for their manuscripts. Commercial publishers have moved quickly to meet the demand for new publishing outlets and have aggressively pursued publication of high impact journals formerly published by nonprofit scholarly associations. In addition to the proliferation of publications, there is a heavy monopoly in the publishing industry, with a handful of publishers publishing a majority of the high impact titles.

The library market is vulnerable to these consolidation practices. The producers and consumers of the research—i.e., university faculty—are parties to the process as they strive to publish in the most significant journals. These journals are marketed to university research libraries which cannot afford them but which cannot afford to be without them if researchers are to be productive.

Many believe that the solution lies in changing the patterns of scholarly communication and reward, to reduce the number and increase the quality of publications, and to make noncommercial channels of communication the preferrred means of reporting research results. This will take years to implement and an unprecedented level of cooperation and communication among universities, scientists, publishers, and librarians.

Mann Library annually reviews about 1,500 journals which are of

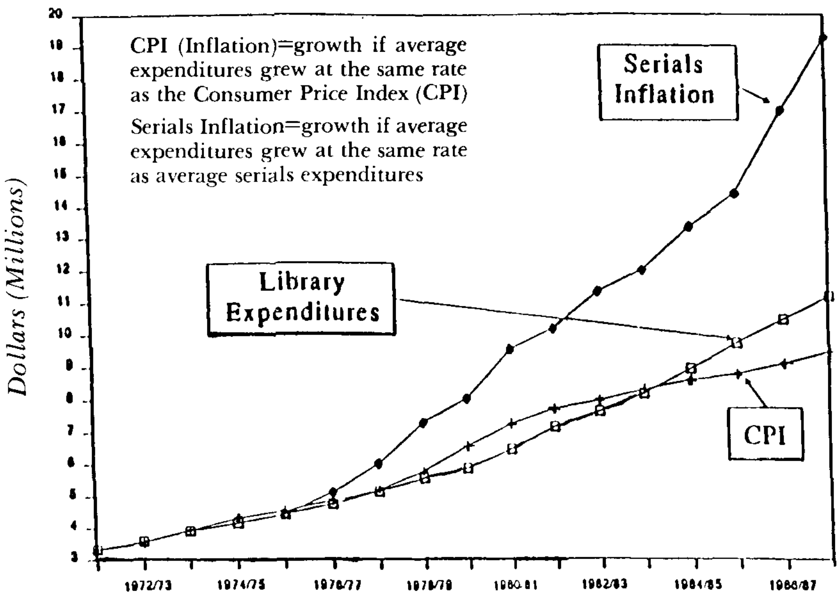
TABLE 4
MANN LIBRARY BIOLOGICAL SCIENCES JOURNALS
PRICE INCREASES OF A REPRESENTATIVE SAMPLE

Title	*1971*	*1989*
Applied and environmental microbiology	$40.00	$220.00
Biochemical journal	$108.00	$1,355.00
Biochemical medicine	$22.00	$224.00
Biochemica et biophysica acta**	$540.00	$4,786.66
Biological abstracts	$880.00	$5,290.00
Bulletin of environmental contamination and toxicology	$28.75	$299.50
Developmental psychobiology	$15.00	$189.00
European journal of biochemistry	$211.60	$1,643.00
Experimental cell research	$180.00	$960.00
International journal of psychoanalysis**	$12.50	$120.00
Journal of agricultural science	$39.00	$305.00
Journal of association of official analytical chemists	$17.50	$125.00
Journal of biological chemistry	$75.00	$490.00
Journal of experimental biology	$39.00	$685.00
Journal of general microbiology	$100.00	$670.00
Journal of ichthyology	$78.00	$505.00
Journal of molecular biology	$209.60	$1,368.00
Journal of neurochemistry	$72.36	$810.00
Molecular biology*	$115.00	$935.00
Parasitology	$46.00	$288.00
Perceptual and motor skills	$40.00	$189.00
Photochemistry and photobiology	$80.00	$420.00
Phytochemistry	$67.50	$580.00
Psychological reports	$40.00	$195.00
Psychosomatic medicine	$20.00	$195.00
Soil biology and biochemistry	$30.00	$330.00
Virology	$100.00	$768.00
Total cost for year	$3,206.81	$23,945.16
Percent change in total cost		646.7
Average cost/title	$118.77	$886.86
Adjusted for cancellations:		
Adjusted total cost for year	$2,539.31	$18,103.50
Percent change in adjusted total		612.9
Adjusted average cost/title	$105.80	$754.31

* cancelled beginning 1984
** cancelled beginning 1989
Total increase of cost of sample titles 1971-1989 = 646.7 percent
Total increase of cost of sample titles 1971-1989 (minus cancellations) = 612.9 percent

Mann Library annually reviews about 1,500 journals which are of potential interest to faculty and staff. The majority of the titles are new. Of these, an average of about 150 paid subscriptions are added each year. Three years ago Mann began to compile a desiderata file of new highly desirable but unaffordable journal titles. There are now 275 titles in this file costing over $38,000. The file does not include hundreds of additional titles rejected over the past three years which would be desirable but are simply beyond the budget; nor does it take into account the thousands of desirable titles rejected over the past two decades.

Production of Information in Electronic Form. The publication of data and information in electronic form is a result of the revolution in



The figure was created using actual 1975-76 average budget figures multiplied by the same growth seen each year for serials expenditures

Figure 1. Overall ARL Library Expenditures and the Consumer Price Index

computer technology. Increasingly, information is being produced and stored in electronic form. Much of this electronic information has never before been available, and, even where it is also available in print, the retrieval, manipulation, and synthesis capabilities of the electronic media enable uses which are impossible or impractical with print formats. Users need these capabilities.

Today a proliferation of computer files is available. In 1985 there were 1,084 numeric databases listed in the *Computer Readable Databases Directory* (1989). In 1988 the directory listed 1,278 numeric databases—an 18 percent increase in three years. In 1985 the directory listed 535 full-text databases and in 1988 1,285—a 140 percent increase in three years. In 1978 the online information industry generated over $500 million in revenues. In 1987 its revenues were over $3 billion—a 500 percent increase. In 1983 the civilian departments in the federal government distributed 1,461 information products electronically. In 1987 they distributed 6,261 products electronically (U.S. Congress, Office of Technology Assessment [OTA], 1988).

This new form of publishing and this new genre of information demands "add-on" dollars to the acquisitions budget. The costs of electronic resources can be examined by again using Mann Library as a case study.

Costs of Electronic Resources

Microcomputer Software. The software collection in Mann Library provides a good example of the demand for electronic resources. In 1988/89, the software packages circulated 47,376 times. This phenomenal use level of a small collection represents a higher annual circulation count than book circulation counts in seven of the seventeen Cornell libraries. The use per title is the highest of any collection on campus. The average cost per title of a stand-alone software package is $250. Software packages which will be used on a local area network cost an average of $750.

CD-ROM (Compact Disk-Read Only Memory). Mann's investment in compact disc products has proven extraordinarily cost effective. A research project to gauge the use of CD-ROM databases revealed an average of 318 uses per month of an agricultural database. This averages out to about $1 per search compared with an average online search cost of $15.29. The purchase of CD-ROM databases has dramatically increased the use of these databases by democratizing the access. Thousands of students who could not afford to pay for online searches are now searching these databases without charge in Mann Library. Mann currently has a desiderata file of CD-ROM purchases totaling over $25,000 per year.

Computer Files. These include both bibliographic databases and non-bibliographic files including numeric, full-text, directory, statistical, graphic, and transactional data. The files are commonly on magnetic tape, but may also be available on a floppy disc or CD-ROM. Examples of bibliographic data files mounted on the campus mainframes are AGRICOLA (1980-present) and subsets of BIOSIS (1985-present) in nutrition, entomology, and genetics.

The costs of mounting bibliographic databases are high. For example, the cost of acquiring the *Life Sciences Collection* to mount locally for unlimited use by faculty and students is $60,795 per year not including computer storage cost. The cost of acquiring the last eight years of *Science Citation Index* for local access, exclusive of computer storage, is about $150,000 per year.

Mann is presently conducting research to examine under which circumstances the local loading of bibliographic files is cost effective. The AGRICOLA database and three BIOSIS subsets have been loaded on a campus mainframe and are searchable in offices and laboratories using BRS software.

Using AGRICOLA as the example, costs are listed for: local loading of AGRICOLA for multiple access from offices and laboratories (see Table 5), compact disc based workstation access in the library (see Table 6), and remote online access through BRS and DIALOG (see Table 7).

As is clear, costs and use may not justify purchase of computerized information for loading locally on campus facilities; providing access to files stored elsewhere can be the most cost-effective means of making

TABLE 5
COSTS OF LOCAL ONLINE ACCESS
AGRICOLA (3 YEARS)

Item	*Amount*
Magnetic storage	$35,000
*Search-and-retrieval software license	
Year 1 license	$19,000-52,000+
Year 1 maintenance	$1,800-4,950+
Year 2	$2,400-6,600+
Year 3	$2,400-6,600+
Total	$25,600-70,150+
**Database acquisition (NTIS charges)	
Year 1	$5,000
Year 2	$1,500
Year 3	$1,500
Total	$8,000
***Database processing (BRS Onsite charges)	
Year 1	$10,000
Year 2	$6,000
Year 3	$6,000
Total	$22,000
†Database use (NAL charges)	
Year 1	$5,000
Year 2	$5,000
Year 3	$5,000
Total	$15,000
Grand total	$105,600-150,150 plus computer

*Search-and-retrieval software based on current BRS/Search pricing
**Database acquisition fees based on current NTIS charges
***Database processing fees based on BRS "Onsite" program
†Database use fees based on NAL's charges to land-grant institutions

TABLE 6
COSTS OF COMPACT DISK BASED WORKSTATION ACCESS
AGRICOLA (3 YEARS)

Hardware	*Amount*
PC-AT compatible micro with fixed disk	$2,000
CD drive	$850
Printer	$450
Workstation furniture	$500
Total	$3,800
Data	*Amount*
Archival disks	$1,000
Year 1 subscription	$950
Year 2 subscription	$950
Year 3 subscription	$950
Total	$3,850
Grand total	$7,650

the information available. Mann currently spends about $36,000 per year to subsidize access to remote databases for faculty and students. Given the growth in number and importance of databases and the impracticality of mounting them all locally, this expenditure could easily double over the next four years. Examples of nonbibliographic computer files purchased are:

—Geoecology Data Base (environmental data)
—GenBank (genetic code sequence library)
—Census of Agriculture
—Foreign Production, Supply and Distribution of Agricultural Commodities (1947-1988)
—Climod (weather data)
—Farm Land Value, 1982.

Hundreds of new computer files are becoming available each year in the subject areas of agricultural libraries. The growth in computer files can be documented by an analysis of *Computer-Readable Databases: A Directory and Sourcebook* (1989). This source lists 1,184 files in Science/Technology/Engineering and 433 files in health and life sciences. The *Agricultural Databases Directory* (Williams & Robbins, 1985, which is already four years out of date, lists 428 databases in the field of agriculture alone. Libraries are still at the beginning of what will be a phenomenal growth in database publishing and use of electronic information resources.

Mann collects computer files in the same subject areas as the print collection—i.e., agriculture, life sciences, some social sciences, and medicine. The range of prices has been from $150 to $10,000. Government tapes have cost around $200 but the price is increasing and will range from $1,000 to $6,000. Table 8, based on projections at Mann Library, indicates budget increases needed to purchase electronic formats at appropriate levels.

Inaccessibility of Electronic Data

Federal Data. The federal government collects and distributes vast quantities of information within the general collection areas of agriculture and the life sciences and the related social sciences, including education and nutritional science.

The Department of Agriculture is one of the largest producers of electronic information in these areas, but the Bureau of the Census probably produces more total data on computer files than any other government agency. Many other government agencies produce computer files, varying widely in number, kind, and quality of databases available. Mann attempted to learn more about data availability by selecting six files listed in Zarozny (1987) which seemed likely to be of interest to patrons. Inquiries were sent to the source agencies asking

TABLE 7
COSTS OF REMOTE ONLINE ACCESS THROUGH BRS AND DIALOG AGRICOLA (3 YEARS)

Year 1	$2,755
Year 2	3,168
*Year 3	$792
Total	$6,715

*Year in which AGRICOLA on CD was installed.

TABLE 8
INCREASE NEEDED IN ACQUISITIONS DOLLARS FOR PURCHASE OF ELECTRONIC RESOURCES (EXPRESSED IN 88/89 TERMS)

Resource	*Dollar Increase*	*Percentage of Total Acquisitions*
Microcomputer software	12,000	1.4
CD-ROM	25,000	2.9
Computer files	120,000	14.3
Access	36,000	4.3
Total	193,000	22.9

about access to those specific files and requesting a list of all other computer files. The agencies were: the Office of Migratory Bird Management of the Fish and Wildlife Service; U.S. Geological Survey, Coastal and Estuarine Assessments Branch; and the National Oceanographic Data Center (NODC) of the National Oceanic and Atmospheric Administration; Environmental Analysis Branch of the Army Corps of Engineers; and Fire and Aviation Management within the U.S. Forest Service. Two agncies provided extensive documentation on ways of accessing a variety of data files—Earth Sciences Data Directory and the NODC Users Guide. One agency sent an explanation of why it prefers to process data requests within its office (Duck Breeding Ground Survey), and one sent documentation for a single file (National Forest Fire Occurrence Data Library). The office of the Army Corps of Engineers, listed in Zarozny (1987), called to say that it was not aware of having any computer data.

This small sample is representative of the difficulties encountered in locating computer files within government agencies. A similar "form" request to USDA agencies resulted in the same range of responses. Agencies often do not understand a general library request for data, and in many cases the agency has no set mechanism for public access to their electronically stored information. This confusion is the outcome of a lack of policy in the federal government. The Office of

Technology Assessment recently released a report addressing the issue. The thrust of the report is illustrated by the following quote:

> OTA has concluded that congressional action is urgently needed to resolve Federal information dissemination issues and to set the direction of Federal activities for years to come. The government is at a crucial point where opportunities presented by the information technologies, such as productivity and cost-effective improvements, are substantial. However, the stakes, including preservation and/or enhancement of public access to government information plus maintenance of the fiscal and administrative responsibilities of the agencies, are high and need to be carefully balanced by Congress. (U.S. Congress, OTA, 1988)

A coherent policy is crucial. Presently, agencies disseminate data for the cost of a blank tape or they charge from $150 to $6,000 for a tape. In all cases the tapes contain raw data. The decision of who should provide what level of access to federal information has profound implications for continued equitable access to that information. Many questions need answers. Who should have government information? Who should get it free and who should have to pay? How should it be distributed? Who should be allowed to make a profit from it?

The same principles which lay behind the creation of the Federal Depository Library program should drive the policies covering electronic information. Taxes pay for the generation of the information and taxpayers should not have to pay again to use it. In addition, the information must be freely available to the citizens of this nation if a democracy is to be sustained. The premise is that libraries should disseminate electronic information as they do print.

In the absence of a federal policy on how the federal government's electronic data will be made accessible, private enterprises are stepping in and creating value-added data products. They purchase federal data, add ease-of-use features, statistical or graphics software, or additional information, and sell the enhanced product. In some cases they merge data from several sources to create a product to appeal to a specific audience.

An example of such value-added products is the Agribusiness database produced by Pioneer Hi-Bred. This database, accessible through the Dialog system, contains selected full-text federal and state information as well as bibliographic citations to the literature from several hundred journals.

AgriData, based in Milwaukee, Wisconsin, offers access to USDA information through its own dial-up system. Agribusiness also uses the same data. Both of these companies have created value-added databases. They have added related files from state and private sources to complement the federal files. Furthermore, in the case of Agribusiness, the data are mastered onto a compact disc every three months.

This multiplicity creates a dilemma which is well illustrated by *Vegetable Situation and Outlook Annual Yearbook* (USDA, 1988). The yearbook is produced by the Economic Research Service and contains time series on production for various vegetable crops and a narrative summary of the statistics. In 1988 the annual data were issued by the USDA on November 1 and transmitted to their EDI system that same day. Dialcom loaded the narrative portion of the report. Martin Marietta loaded the full tables. The USDA received the paper copy from the printer on November 18th. Presumably this paper copy was mailed to subscribers within the next few weeks. The data were loaded onto the Agribusiness file on DIALOG on November 29th and they appeared on the compact disc dated 1985-November 1988 distributed by Agribusiness in January 1989. If a depository library were only receiving the microform it could be 1990 before receipt depending on the status and efficiency of the company with the microfiche contract. To provide access to any other formats would require the depository library to pay additional costs.

Private Data. Data ownership can create barriers to data sharing. Researchers are hesitant to share their raw data, both because it represents their "capital" and lest it be subject to misuse. There is, however, a trend toward increased sharing.

Professors are creating local databases to be accessed by the members of their laboratories or for their students to use. Researchers in similar fields are trading data. At the national level there is also some sharing of data files. GenBank is an example of such a file. In 1982 the GenBank Genetic Sequence Data Bank was created by the National Institutes of Health (NIH). The database is housed on the computers at the Los Alamos National Laboratory and access is provided by IntelliGenetics, Inc. of Mountain View, California. The database aims to be a complete record of reported nucleic acid sequences and is cataloged and annotated for sites of biological significance. Researchers are encouraged to submit sequences to the databank. There is no cost for submission.

As the number of files grows, and the awareness of the value of computer files spreads, the pressure to share data will increase. This trend can be accelerated if libraries and other information providers create databases which list computer files. For example, BIOSIS plans to create a list of data sets of use to biologists and put the list on their online system.

The print industry has developed a reasonably efficient and effective method of distributing monographs and serials. Through vendors, jobbers, established catalogs of in-print materials, and direct mail lists, publishers are able to inform libraries about their publications. By comparison, computer files can and are "published" by almost anyone with access to the hardware which generates the information. Most electronic information producers do not yet realize that libraries might be interested in computer files; they tend to focus marketing on the end-user. Because of these differences, locating computer files is a more complicated and extensive process than locating print materials. At the federal level, the National Technical Information Service (NTIS) markets some data sets but has no monopoloy or mandate to serve as a clearinghouse.

Fragile Data. Data collected by agencies or companies for their own purposes can be of interest to researchers. Often, outsiders are granted access to the data or the agency ships the data to another machine designed for public access. At other times the agency generates a print report. Sometimes the next block of data is loaded into the agency's system and the earlier data are discarded. For example, the Chicago Board of Trade collects daily data on trading activity. These data are cumulated into monthly summaries and published as print tables. The computer files of the data remain on the computers until the space is needed to generate another summary, generally about two months. The earlier files are then deleted. The original data of the individual trader activity is archived in case the Board of Trade needs to re-examine it, but those data are confidential and cannot be released. A researcher wanting to chart patterns in trading has to rekey the monthly summary data from the print tables.

If agencies are unwilling or unable to archive and distribute historical data for public use, libraries should establish arrangements to be the depository for datasets in a particular subject area along the pattern of the RLIN conspectus. Alternate solutions would be the creation of an official archive or, in the case of federal information, the designation of an existing federal agency as an archive.

The routine reviewing structure that exists for print materials has not been established for computer files. Until this exists, gaining access to electronic information will be an extremely time-consuming process.

In summary, the trend toward a crisis in publishing is characterized by:

—the expenditure of increasing amounts of money to buy less of the scholarly publishing due to poor foreign exchange rates on the American dollar and price increases of publications far beyond the inflation rates in the costs of publishing;
—increase in publishing driven by twigging, the development of new areas of knowledge, and the publish or perish syndrome;
—the production of information in electronic form in both the public and private sectors driving the need for "add-on" acquisitions dollars;
—lack of structure to allow systematic review and acquisition of electronic information;
—failure of the federal government to provide a cohesive policy for the dissemination of electronic information; and
—erosion of equitable access to federal information in electronic formats.

Deterioration of the Records of Agricultural Science Scholarship

The Library of Congress, the National Library of Medicine, and the National Agricultural Library hold approximately 5 million volumes in the fields of science and technology. Of these, about 1 million are threatened by serious deterioration. In the major research libraries across the United States, the number is closer to 25 percent of each collection which is in jeopardy.

Within this body of materials there can be none of greater importance to this country and to the world than the records of knowledge in the agricultural sciences. They do not simply provide solutions to farmers' problems but are the basis for helping the world to feed itself. The agricultural libraries of this nation are responsible for preserving this heritage and passing it on to scholars and citizens of tomorrow. Today the body of literature in the agricultural sciences is immense and growing fiercely. In the 1940s, the *Bibliography of Agriculture* provided fewer than 10,000 citations to the primary and specialized literature. In recent years, there have been 200,000 citations per year to journal articles, reports, and monographs in the agricultural sciences. There are 12,000 journals alone in the agricultural sciences and approximately 100,000 scientific and technical journals published in the world.

Before preservation of the agricultural science literature can proceed systematically, this vast amount of publishing must be sorted through to identify a heritage collection. A heritage collection can be defined as that material which provides optimal value to researchers, teachers, and policy makers in the agricultural sciences.

Such a comprehensive work has never been undertaken, but broadly it would involve the identification, from the inception of publishing in a given discipline to the present, of the most significant primary monographs, primary serials, reference collection titles, and specialized literature idiosyncratic to that discipline—e.g., *Working Papers* in Agricultural Economics. The heritage collection would be selected to provide a rounded selection of literature in the disciplines to serve research, instruction, and policy making. This differs, for example, from the "most important" literature identified by the Institute for Scientific Information through its analysis of journal citations. That analysis is almost exclusively of research literature. It is also important that the heritage collection be selected not just on a quantitative basis, which is the case with citation counting, but on the basis of quality. This does not exclude citation analysis, but does require other mechanisms to introduce the quality factor, such as review by librarians, many scholars, and national and international associations.

In 1986, the Commission on Preservation and Access was established as a result of recommendations by a committee sponsored by the Council on Library Resources. The primary goal of the commission is to "foster, develop and support systematic and purposeful collaboration among all libraries...to ensure the preservation of the human record"

(Council on Library Resources Reports [CLR], 1988). The modus operandi is to support a range of research and demonstration projects, consultants, technical advice, and scholarly expertise necessary for the development of a massive preservation effort.

The establishment of the commission gives weight to the significance and magnitude of the preservation problem in the United States. The actual preservation decisions and tasks, however, still have to be carried out and funded at the local level, probably within a consortium arrangement. For agricultural libraries this means a grassroots level preservation program stimulated and carried out by a collaboration of land-grant libraries and the National Agricultural Library. A blueprint needs to be developed for preserving the heritage collection of agricultural science literature to be passed on to the United States of tomorrow.

One way of approaching preservation would be discipline by discipline. The process would involve:

1. identification of the heritage list;
2. review of the titles on the list for severely embrittled volumes, and decisions made to replace those with commercially available microform or reprint, or to microfilm—preserving or not preserving original plates, or to photocopy, again with or without preserving original plates; and
3. review of the titles on the list for conservation in their original condition, and decisions made to restore bindings, recase, reback, repair, or resew.

Table 9 contains cost estimates for various preservation and conservation activities. Figures not attributed to other sources are based on studies at Mann Library; these are consistent with comparable figures at other institutions.

Although microfilm currently represents the best and most cost-effective method, there are other means of preservation storage. These include magnetic storage of images on videotape, encoded information on computer tape and discs, and laser-based digital/optical systems. These vary in ease of use, performance, cost of originals and copies, equipment requirements, methods of reproduction, and storage capacity. There are special technical factors to be considered in developing electronic storage systems for preservation, and it has been suggested that this is an important area in which the Commission on Preservation and Access could become involved (CLR Reports, 1988). Optical media are particularly suited to preservation needs in science and technology.

It is important that the national scholarly associations be made aware of the need for preservation of the literature of their disciplines. Their support and efforts will be very helpful as libraries pursue funding for these programs.

Toward a New Literacy

Literacy can be defined as having the skills one needs to find, use,

TABLE 9
COST FIGURES FOR PRESERVATION AND CONSERVATION ACTIVITIES

Activity	*Average Cost/Volume ($)*
*Microfilming	61.64
Photocopy	80.00
Preservation of original plates (est. = 17/volume)	51.00
Recasing	25.00
Reback	28.00
Restore binding	60.00
Repair, resew, rebind	200.00
Rudimentary repair	65.00

*Microfilming costs are based on: (1) data from recent participation in the RLG Cooperative Preservation Microfilming Program (CPMP), (2) Patti McClung's cost analysis of the CPMP participant's operations, and (3) completion of McClung's "Worksheet for estimating project costs" (pp. 169-170 in *Preservation Microfilming-A guide for librarians and archivists.* Chicago, IL: ALA, 1987).

and communicate the information necessary to survive in society. The basic skills of literacy as we know it today are the abilities to read and write (Webster's, 1976). As Benjamin Compaine (1984) of the Center for Information Policy Research at Harvard University points out, this has not always been the case, however (p. 6). Before the written record came into widespread use in eleventh-century England, the oral tradition dominated. To be literate meant the ability to compose and recite orally. The spoken word was the legally valid record.

The emergence of the quill pen and the production of written texts on paper were the beginning of the technologies which have brought us to the current concept of literacy; in addition, the steam driven rotary press, the spread of railroads, and innovation in the manufacturing of paper have also played a significant role in stimulating development of literacy skills which enable individuals to find, use, and communicate the information needed to function in society. The current notion of literacy has evolved from the technology of the quill pen, paper, movable type, and the mechanically powered rotary press. The group of skills called *literacy* has evolved with technology and use of information in the print tradition.

Today, information is produced by computer. It is stored in electronic form, retrieved in complex ways, and distributed via telecommunications. As we move toward the twenty-first century, this technology increasingly will be the means of generating and storing information. To be in a position to exploit information—i.e., to create, locate, use, and distribute information—society will have to shift its perceptions and abilities related to information formats. Individuals will have to acquire a new bundle of information skills necessary to function in society; in practice they will have to expand the traditional skills of literacy. This new literacy is not simply about programming computers or working a computer; it is not about computer literacy—that is too narrow. This new level of literacy has to do with understanding the role and power of information in society, its use, and misuse; being able to handle the varieties of information formats; understanding the systems used in organizing information; and being able to generate and manipulate information using electronic processes.

The foundation of this new literacy is the social and cultural change being driven by the increasing use of computer technology. It is clear that there is already precedent in history for the influence of technology on literacy. History shows that literacy is dynamic and not static. Today computer technology is being placed in the hands of the people. Millions will be faced with a new way of dealing with substance. Computer technology and telecommunications is forcing a fundamental innovation in the means for using and communicating information. In short, it is forcing an expansion of traditional literacy skills.

In the literature of education today one can find extensive acknowledgment of the reality of the computer technology and information era. One can also find extensive examination of what constitutes an excellent undergraduate education for the 1980s with particular concern expressed for the state of student literacy. Interestingly, however, it is impossible to find any discussion of the implication of information technology for traditional literacy and the responsibility of undergraduate education to respond to this. For example, *A Nation at Risk* (U.S. Department of Education, 1983) states that effective participation in our "learning society" requires each person to be able to manage complex information in electronic and digital form and therefore places great importance on computer literacy. This is not enough; it is too narrow. The forward-looking discussion paper by Benjamin Compaine (1984) does actually address a concept of "new literacy." He asserts that computer literacy is not enough and then strongly presents the possibility that a new literacy might indeed evolve as the result of the information age. This is not enough either. The development of a level of literacy essential to functioning in society cannot be left simply to evolution. It has to be cognitively developed.

Among those who should be most concerned about the implications of information technology on literacy in society are educators, particularly in terms of curriculum design. Questions need to be raised concerning what schools and higher education should be teaching. If the education community is slow to understand and respond to changes, the loss will be in the long term effects on society and its inability to compete with others who are more responsive as educators.

Bernice MacDonald (1966), in *Literacy Activities in Public Libraries,* identified the question: "Is it the library's job to teach?" and concluded that the debate was probably won by those who said: "It is the library's job to see that the teaching gets done" (p. 24).

Libraries have a long history of involvement in literacy programs. Democratization of society and its concern with every citizen's need to know have put a premium on the individual's ability to read (Monroe, 1986). Public libraries have held the philosophy that:

> the public library has a responsibility to maintain the climate for use of the library's resources; a literate society is essential to its continued use. As Ranganathan has made clear, libraries have a responsibility to their resources to see that they are used by people who need them. (MacDonald, 1966, p. 35)

Helen Lyman (1977), in *Literacy and the Nation's Libraries,* perceived literacy as providing the power to the literate to deal with the tasks of daily living.

In the land-grant university environment, the same question and answer are pertinent. In fact, traditionally libraries have done some teaching. The purpose has been to instruct in the use of specific bibliographic tools. As some of these tools have become computerized, a number of libraries have taught users how to work with the electronic versions.

This does not acknowledge the basic principle at issue. The technology of the computer is forcing a fundamental innovation in the way all information will be conceptualized, retrieved, analyzed, and synthesized. As the transition occurs from resources in print to electronic form, the traditional skills of reading and writing are no longer sufficient. To these must be added new skills of retrieving information from a variety of electronic systems and formats and of organizing and manipulating information using electronic processes. The basic principle at issue is to produce students who will be electronically literate. Libraries need to teach, or see that teaching occurs, to provide students with the computer skills required to find, use, and communicate information as it moves from the print tradition to the electronic.

In practical terms it could be said that information literate graduates will:

—understand standard systems for the organization of information;
—have the ability to retrieve information from a variety of systems and in various formats; and
—have the ability to organize, manage, and access information for various purposes.

Examples of skills that students will have include:

—use of telecommunications software and systems;
—use of command languages and Boolean logic to search computerized databases and files on mainframes;
—use of network connections to download information and store it on a floppy disc;
—use of microcomputer software such as word processors, hypertext, database management packages; and
—use of the online catalog to locate library holdings records.

The case has been made earlier in this article that if the United States is to remain internationally competitive in an age when information has become a strategic commodity, libraries, and land-grant libraries particularly, must take responsibility for applying modern computer technologies to the storage, retrieval, and management of information. The followup case is now being made that libraries must also concern themselves with developing in the user, expanded literacy skills appropriate to being able to make use of this information. In the land-grant spirit, the libraries must help people help themselves.

TRENDS IN LAND-GRANT UNIVERSITIES

This article began by reviewing the land-grant mission—one of the great and enduring ideas in American education. Senator Morrill's fundamental idea in the mid-nineteenth century was to link the knowledge generated within the university to solving the everyday problems of the people.

Morrill applied the idea to agriculture since that was the principal occupation of a large number of the population.

> The draftsmen of the Morrill Act were wise enough to foresee that this might not always be so. They carefully included in their stated objective the promotion of "the liberal and practical education of the industrial classes in the several pursuits and professions in life." (Fleming, 1987, p. 11)

This article will conclude by reviewing briefly the perspective of the 1980s on the conduct of that historic mission.

At this point in the history of the land-grant "contract," the colleges of agriculture in the land-grant universities are being challenged to reassess seriously their interpretation and implementation of the land-grant "contract." The substance of the challenge is expressed in an article by McDowell (1988):

> The conclusion is clear. Without change, the land-grant colleges of agriculture will find themselves caught in a downward spiral of ever declining political and budgetary support. Faculty will increasingly set their own agenda in response to the highest grant or contract bidder. The land-grant universities will become as bad as Harvard and Yale, producing knowledge fundamentally oriented to special interests rather than broadly based public interest.
>
> The alternative calls for leadership, especially from the traditional agricultural groups. They must act to reverse the spiral by insisting that the colleges of agriculture address issues important to non-farming audiences. (pp. 18-21)

In another article Schuh (1986) states:

> The land-grant universities have lost their way. Faculties have become introverted in their disciplines...land-grant universities have found it difficult to relate to new and changed social conditions.
>
> For these institutions to be relevant to the problems of society, they need major changes in their programs. But for a variety of reasons many land-grant universities find themselves paralyzed. Somewhat surprisingly each university considers its particular problems unique. This is not the case. The important problems are systemic.

> The basic challenge of today's land-grant university is to bridge the gap between society's current problems and the frontiers of knowledge.
>
> To meet this challenge presidents, deans and faculty must reinstill a mission orientation into our land-grant universities. They must revitalize the tripartite mission of teaching, research and extension...to devise solutions for the pressing problems of our society.

Connor (1989) observes:

> Undergraduate enrollment in the agricultural sciences at land-grant universities declined by 38 percent in the nine years from 1978 to 1987 according to a 1988 report to the National Association of State Universities and Land-Grant Colleges. All disciplines experienced a decline except for food science/human nutrition and related biological/physical sciences...agricultural colleges have a definite enrollment problem.

The agricultural libraries of the United States are inextricably bound to the land-grant mission and its implementation. These libraries have the responsibility to understand the perspective of the 1980s on the mission and its implementation, and to ally themselves with courses of action identified for the 1990s. The following are emerging priorities established by at least one college of agriculture and life sciences in the United States; most of these are similar to priorities recently recommended within the USDA (USDA, Joint Council), 1989:

—food safety and nutrition;
—environmental issues;
—profitability and competitiveness of food and agricultural businesses;
—community and rural development;
—biotechnology and biological research;
—improving educational opportunities for underrepresented minority undergraduate and graduate students;
—the changing mix of undergraduate students and the cost of higher education; and
—global agriculture and food systems.

If these challenges are not addressed successfully, what will be the cost?

> There will still be universities where the land-grants are now and they may even retain the land-grant designation as a historical curiosity. Their faculty will likely think of them as great centers for higher learning. But like Harvard, Yale and MIT, they will be sold piecemeal to the highest bidders. They will serve and produce society's new elites, but they will no longer serve those who cannot qualify to sit in their classrooms. (Connor, 1989)

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Agricultural Document Delivery: Strategies for the Future

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ABSTRACT

DOCUMENT DELIVERY AND interlibrary loan have changed dramatically in recent decades, moving from providing the patron with original materials to providing a photocopy, telefacsimile, and even electronically formatted material. This article discusses ongoing new technology projects which may influence document delivery. CD-ROM, online catalogs and databases, OCLC, AGRICOLA, ADONIS, Group IV telefacsimile, high-speed digital communication networks, text digitizing, expert systems, and hypermedia are all part of continuing research and development in document delivery. Successful libraries will embrace the future by incorporating new technology into daily routines, by instituting strategic planning to evaluate and restructure multiple level service options, education, and training and collection development, by adopting entrepreneurial attitudes, values, and production practices and by establishing stronger networks.

INTRODUCTION

The factors affecting document delivery are varied and universal. The explosion of scientific research and publishing both in developed and developing nations places enormous pressure on researchers to identify all applicable information and data. They can no longer limit themselves to staying abreast of the work being done at established, well-known research centers but instead must seek out those small pockets of activity where the application of a little-known method may change the entire focus of their research. In addition, as the information needs of practitioners become more varied and sophisticated, pressure is placed

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on libraries to acquire and disseminate a wider variety of material and value-added media in nontraditional formats. As technology and improved global communication change perceptions of the world, and agriculture and the environment reassert themselves as primary global concerns, the need for agricultural document delivery grows exponentially. This article addresses some of the issues and factors which agricultural library managers and document delivery librarians are likely to face in meeting the needs of their users in the near future.

BACKGROUND

Document delivery procedures for agricultural materials are primarily the same as for other disciplines; however, an attempt will be made to highlight those projects or resources that have implications for agricultural document delivery. No attempt has been made to produce a how-to manual nor to describe the basics of document delivery. For information on these and other topics, readers should refer to publications such as Bennett, 1984; Taleb, 1986; Morris and Brautigam, 1988; Boucher, 1984 and 1989; Harvey, 1988; Library of Congress, 1988; Buckland, 1987; Kennedy, 1987; Millson, 1988; Boss and McQueen, 1983; Line, 1983 and 1985; Jackson, 1982; Thomas, 1988; National Agricultural Library, 1988; and Food and Agriculture Organization of the United Nations, 1987.

Document delivery has progressed rapidly from the days of interlibrary lending between libraries to include full-text retrieval, networking, outreach, the use of document delivery vendors, and a wide range of technological innovation. In recent decades, significant changes and developments have occurred in the field of library and information science. The introduction of photocopiers in the early 1960s signaled a significant improvement in the dissemination of knowledge. Users no longer had to travel to the large research library or hope that the ILL (interlibrary loan) librarian could borrow the original material. Instead, patrons became accustomed to receiving a photocopy that could be retained in lieu of the short-term temporary loan of the original source material. The rapid increase in the number of online indexed citations, which reflected worldwide research and literature, prompted document delivery librarians to expand their knowledge and operating bases from the local and regional arena to the international community.

The development and expanded availability of bibliographic utilities, such as OCLC (Online Computer Library Center), WLN (Western Library Network), and RLIN (Research Libraries Information Network), streamlined and simplified the front end of the ILL process. As a result, ILL processing shifted from reference librarians performing subject access searches and relying on their extensive knowledge of the subject strengths of lending libraries to library technicians verifying citations and identifying locations online. The practice of cooperative exchange was gradually replaced by fees for service and restrictive lending policies as the economic impact of increased ILL volume was experienced by libraries of all sizes.

"Agriculture" encompasses a broad range of sciences and the social sciences and overlaps with the chemical, medical, and environmental disciplines. The scientific literature of agriculture and related fields has increased considerably. New serials and nonconventional materials are being published, indexed, and cited at a growing rate. New disciplines, such as biotechnology, have been established and are resulting in new journals and publications. While bibliographic information systems such as CABI (CAB International), AGRIS (International Information System for the Agricultural Sciences and Technology), and AGRICOLA (Agricultural OnLine Access) have attempted to keep pace with this increase in publishing, agricultural libraries have not been able to keep up with increased subscription, housing, binding, and preservation costs. Budgetary cutbacks have affected library collections, directly by reducing the purchasing power of the subscription dollar and indirectly by reducing what can be obtained via gift and exchange agreements. Fewer duplicate journal issues and gift titles are available for exchange as libraries: eliminate multiple copy subscriptions in order to maintain the broadest title coverage; evaluate collection development policies and cancel entire subscriptions; and as the numbers of titles published and copies distributed by governments (especially the United States) and universities continue to decline. Two additional factors influencing library collections are: (1) budget and staff reductions in gift and exchange programs which hamper the ability to locate and obtain materials that are available or to enter into new agreements, and (2) the use of traditional reprint exchanges between scientists which continue to dwindle as the costs to purchase and exchange reprints rise.

"Technology is making ease of access to information universal. The general public can, for the first time, use information that has hitherto been available only to those very close to it or in control of it" (Atkinson, 1984, p. 103). Worldwide computer literacy on the part of users, and the introduction of CD-ROM (Compact Disk-Read Only Memory) databases such as AGRICOLA, TOXLINE (TOXicology onLINE), and ASFA (Aquatic Sciences and Fisheries Abstracts), OPACs (Online Public Access Catalogs), and other new technologies into libraries, information centers, and offices of researchers has opened access to the world's literature to a wider audience at a reasonable cost. Without the constraints of cost or time, end users are able to identify more material, some of which may be of marginal interest or use.

Input of state and local citations into AGRICOLA and foreign input into bibliographic databases around the world continues to grow. With the exponential growth in publishing and knowledge of the existence of the data, researchers are requesting delivery of more nonconventional and foreign published materials. Samaha (1987), in a discussion of AGRIS and document delivery, reports that about 20 percent of AGRIS materials are nonconventional documents (i.e., literature which is not readily available or is difficult to obtain through normal bookselling channels) (p. 103). Because of the growing abundance and prevalence of this material, the document delivery process is more difficult and complex. The increased availability of SDI (Selective Dissemination of Information) services in academic and business libraries is resulting in a rise in volume of requests, and librarians are finding that the scope of the requests often surpasses the scope of the collection.

The ease of identification of citations occasionally has fostered unrealistic expectations that the materials are readily available or can be obtained easily. Whether the library is located in a developed or developing country, librarians who have tried to obtain materials published by local, state, national, or provincial agencies or academic institutions are familiar with the difficulties and complexities of borrowing or purchasing these materials. It is the volume, complexity, and cost of document delivery activity which is leading agricultural libraries to develop new methods of interacting and cooperating with each other through networking, expanding their resource pool, and exploring and implementing innovative and technological approaches to resource sharing. As Dougherty (1985) describes it, the inability to obtain material as quickly as it was identified and located "can be characterized as the collision of two eras: the technological age of bibliographic access colliding with the horse-and-buggy era of document delivery" (p. 385).

Coping Strategies for Today and Tomorrow

The methods of generating and transmitting interlibrary loan requests in today's document delivery unit also have undergone significant change, especially in the last ten years. The patron's need for fast and/or low cost delivery often determines the method of requesting a document. OCLC and other online ILL ordering systems such as the NCC/IBL (Nederlandse Centrale Catalogus van Boeken, Perodieken en Congressen/Interbibliothecair Leennerkeer) in the Netherlands are the methods of choice for verifying and processing the bulk of routine requests. Ease of entry, multiple routing, improved response time, lower overall cost, and access to a vast amount of bibliographic holdings data are the primary attractions of these systems. Libraries are also using a variety of other sources and systems to procure materials outside of traditional interlibrary loan processes and are implementing multiple service levels and options to satisfy the demands of their patrons.

Patrons are often unaware or unconcerned about how material is obtained, especially when it is received within a reasonable time. As White (1987) observes:

> If the librarian provides the needed information it should not be necessary to inform the requester whether it came off the shelves or from across the continent. Why should the user care?...Today it is access rather than ownership which is the important question to users. (p. 43)

While many materials are provided from traditional ILL sources (i.e., other libraries), commercial vendors provide librarians with an additional option when coping with subscription cancellations and budget and staff reductions. For too long agricultural libraries considered these organizations as a resource strictly for the wealthy corporate library. However, librarians are increasingly using this unorthodox approach to provide service. As the use of commercial document providers escalates, such organizations are part of a growing and increasingly competitive segment of the information industry.

Commercial vendors can be easily incorporated into routine document delivery activities since many of the vendors have become bibliographic utility participants, thereby streamlining the methods of access and simplifying billing. The ability to use OCLC to route requests to Chemical Abstracts, UMI (University Microfilms International), ISI (Institute for Scientific Information), and BLDSC (British Library Document Supply Centre) has diminished the reluctance to use them. OCLC reports that more than 133,000 requests were filled by materials purchased or borrowed from document suppliers or resource centers from July 1988 to June 1989 (Cassidy et al., 1989, p. 21). In addition, the prices charged by some of the large suppliers (e.g., $8.95 for a document from ISI and $10.00 for one from CABI) are comparable to or less than the document and copyright fees plus staff and processing costs incurred through the traditional document delivery process.

As the number of commercial vendors increases and their services expand, they are becoming more attractive to individuals wishing to avoid the current restrictions and delays of ILL.

> Both libraries and library networks may find themselves in increasing competition with information and document delivery vendors. University Microfilm and the Institute for Scientific Information, to name just two, have large monograph and serial holdings of their own, with the ability to pinpoint and deliver items to users—a process that bypasses libraries altogether. (Sigl, 1987, p. 9)

Libraries committed to providing premier document delivery service to their patrons will add commercial vendors to their service options in order to provide: "The right information in the right hands at the right time, in the most cost-effective manner possible" (Griffith, 1987, p. 57).

The use of telefacsimile is another strategy for meeting the increased demands of document delivery. Librarians and patrons are rapidly changing their perception of telefacsimile. Advances in the speed of transmission, increased memory capacity for storing and sending documents at off-peak phone rates, improved copy quality, and declining equipment prices have made the use of telefacsimile for document delivery more practical. Group III machines currently dominate the telefacsimile market; Group IV technology, with its higher speed transmission and superb copy quality, is emerging. As document delivery librarians wait for these developments to revolutionize document delivery, they are reluctant to explore other telefacsimile options.

However, recent improvements to Group III machines provide capabilities which can be utilized until Group IV technology is widely implemented. The ability to copy and scan in one step eliminates several processes (photocopy, collation, and quality control of the article) thus reducing staffing and supply costs. In addition, the ability to use copy quality paper in the telefacsimile machines addresses one of the main complaints of patrons, that of smudging and fading of copies received on thermal paper. These improved Group III machines are relatively expensive (approximately $12,000), but prices are expected to decrease.

The business sector has embraced telefacsimile to such an extent that it has become standard operating procedure in many offices. Perhaps the single most important factor in increasing the use of telefacsimile for document delivery is patron acceptance of a telefacsimile copy. Library managers, recognizing this acceptance, have responded by offering a full telefacsimile service option—i.e., use of telefacsimile to transmit the ILL request and to receive the document—to patrons when speed of delivery is essential. Telefacsimile has been successfully integrated into routine document delivery service in, for example, the states of Washington (Moore, 1988) and Pennsylvania (Nyren, 1986), and at the Illinois Research and Reference Center (Mak, 1988). Jackson (1988) suggests that:

> Facsimile will not eliminate or replace existing document delivery methods: it will enhance or supplement them. It deserves to be given serious and ongoing study along with other document delivery systems to ensure that the best method can be chosen for any given situation. (p. 43)

Jackson goes on to predict that "the introduction of telefacsimile equipment will have the same positive effect that the introduction of OCLC terminals for ILL functions had in the early 1980s. The OCLC terminal served as the catalyst for significant improvements in ILL workflow" (p. 40).

Prior to instituting a successful telefacsimile service, and to gain optimal benefit from the service, libraries have found it necessary to evaluate and redesign workflow to determine true costs and to develop and implement new policies and service options. When service was instituted without performing these steps, the program was likely to fail due to unmet expectations and unacceptably high costs. Libraries unable to implement full telefacsimile service either because of high costs or lack of patron acceptance of the telefacsimile copy, can consider partial implementation. At the least, transmitting requests to the library's primary borrowing or vendor resources via telefacsimile can save up to seven days delivery time with minimal additional cost.

Electronic mail offers another means of access which is especially important to those libraries not connected to a bibliographic utility or other network. Electronic mail systems provide direct access for transmission of requests and messages, eliminate mail time, and significantly improve communications. Many libraries are encouraging remote patrons, particularly those in rural areas, to submit requests via local electronic mail systems. Electronic mail is particularly effective for international communications, and many developing countries are exploring its use for document delivery and dissemination of information. International access and/or linking of these systems may be one component of future agricultural document delivery network activities.

Electronic bulletin board systems may prove to be another cost effective method of transmitting and receiving requests, especially within small localized networks. As described by Moore (1987), use of a bulletin board (RBBS-PC software) by the Wisconsin Interlibrary Services (WILS) ILL Network, which receives 90,000 requests a year, reduced costs, increased flexibility, and improved control of requests.

Document delivery librarians, while recognizing that new technology addresses many of the issues in the provision of fast, efficient service to meet users' demands, are exploring new combinations of existing resources and systems. Various options for delivery of materials, such as the U.S. Postal Service, local courier routes, and established national and international express and parcel delivery vendors (such as United Parcel Service [UPS] and AIRBORNE EXPRESS) are being evaluated in terms of cost, speed, ease of use, and guaranteed delivery. Document delivery librarians are employing a combination of delivery options to provide the most appropriate level of service. In addition, librarians are determining the most appropriate method of response to a specific request. The response may be, for example, a negative reply or a request for additional information sent via electronic mail or telefacsimile, or the shipment of original material via one of the delivery service options. In summary, improved response time is no longer strictly concerned with the receipt of the article but encompasses all aspects of "service" from the creation and transmission of the request to the receipt of a status reply and/or delivery of the material.

Trends and Implications for the Future

The following trends and practices may serve as a guide to lead document delivery units through the next decade.

1. Nontraditional and/or underutilized services and resources—such as commercial vendors, telefacsimile, electronic mail, electronic bulletin board systems, and delivery/shipping services (discussed earlier)—are being expanded and enhanced in many libraries. Other libraries will recognize this trend and pursue methods to adopt and incorporate a combination of the elements into their document delivery routines.
2. The results of new technology projects will be incorporated into daily routines.
3. Strategic planning to evaluate and restructure multiple level service options, education, and training and collection development will be instituted.

4. Entrepreneurial attitudes, values, and production practices will be adopted.
5. Stronger networks will be established.

The extent to which these trends will affect individual document delivery operations will depend upon the institutional recognition of the need for change, the level of commitment to identifying and supporting services designed to anticipate and meet user demand, and the degree to which proactive leadership is encouraged.

New Technology Projects

The following new technology projects show the greatest potential for a positive influence on document delivery.

The ADONIS Project

ADONIS, first developed in 1979 by a group of publishers in twelve European countries, is a project to investigate the digital storage of journal literature. As described by Campbell and Stern (1987), ADONIS specifically addresses:

> The exploration of the possibility to share cost savings between libraries and publishers....The ADONIS experiment focuses on the acceptance of a payment per article copied by document supply centers combined with the delivery of information by publishers in a format in which cost saving in the library becomes possible....If the ADONIS experiment is successful, it will have established for document delivery purposes a standard format for compact discs and the work station as required to read and print out from the discs. (p. 100)

A recent review of the project concluded that the basic premise is workable but that the number of titles and publishers involved needs to be expanded and additional technological improvements are needed (e.g., use of jukeboxes, development of methods for storing more data on the discs, improvement of search and display software). At a September 1989 meeting, the centers involved in the trial unanimously recommended that the service become fully operational and that it be offered to a wider audience; the ADONIS board concurred. Almost 200,000 articles are currently on disc and 50,000 prints have been made to date (B. T. Stern, personal communication, October 5, 1989). As reported in the ADONIS News (1989):

> The results show that staff time can be saved, the amount being determined by the location of the workstation and the methods used to retrieve from the index. The time of both conventional photocopying and using the ADONIS workstation varied considerably. Average conventional photocopying times ranged from 3-46 minutes per request and the average ADONIS retrieval/printing time ranged from 1.5-22.0 minutes. Most Centres reported staff time (and therefore cost) savings with three Centres achieving a 50% reduction. Further savings in time can be achieved with the use of a jukebox for large scale operations.

As the system becomes fully operational, widely marketed, and replicated by others, libraries will have rapid access to more titles than can be purchased, stored, or preserved at a reasonable cost by any one library.

Project Quartet

One of the objectives of this research project, funded by the British Library, is to investigate the fundamental technologies involved in large-scale automated document delivery systems. Electronic access over improved digital telephone networks (Integrated Services Digital Network [ISDN]), the ADONIS CD-ROM workstation and Group IV telefacsimile equipment are being combined to create an experimental prototype of a request/delivery system. The project's success may result in expansion to other networks and cost savings through the elimination of labor intensive manual journal handling and photocopying.

> As part of Quartet...University College London (UCL) has been investigating the use of digital telephone networks for document delivery. The system will facilitate the transmission of electronically encoded documents, such as scientific journal articles, usually in facsimile image format, from a central archive to a requesting client. (Tuck, 1988, p. 355)

In reference specifically to agriculture, there are several full-text projects which may have more immediate impact on agricultural document delivery.

The REGIS Project

REGIS (REGional Information System for African Aquaculture), a cooperative international project of the food and Agriculture Organization (FAO) of the United Nations and the National Agricultural Library (NAL), is designed to provide improved access to information on aquaculture in Africa. The prototype system merges two popular technologies, hypermedia and expert systems, into a useful and easy-to-access information retrieval system which runs on a microcomputer. Hypermedia can be used by an expert to link terms or graphics within one or more documents, allowing a user to browse. Expert systems mimic some of the problem solving abilities of human experts in a given field. Together hypermedia and expert systems provide structure, procedural control, and the ability to explore information. Phase II will expand the project to include a selected number of bibliographic citations and explore CD-ROM database connections (Freeman and Hanfman, 1989). The knowledge and experience gained from this project—which connects hypermedia, expert systems, CD-ROM and bibliographic citations—may be applied to future projects resulting in benefits specific to document delivery.

National Agricultural Text Digitizing Project (NATDP)

The National Agricultural Library and forty-four land-grant libraries have entered into a cooperative project to test new methods of capturing full text and images in digital format for publication through media such as CD-ROM discs. Use of CD-ROM laser discs as a storage and dissemination medium allows for rapid local access without telecommunications charges and allows for sophisticated Boolean searching of the full text. The database can be retained in a standard format and utilized in other ways in the future. Both the CD-ROM discs and the retained database also provide the potential for preservation in a medium more stable than paper. Possibilities for electronic document delivery of the digitized collections via telecommunications networks will be examined (for additional information see Andre, et al., 1988).

NAL and the North Carolina State University (NCSU) Libraries and Computing Center are moving a step further with the NATDP to develop and evaluate techniques for electronic distribution, receipt, display, and output of digitized page images. The project will emphasize nonproprietary widely available technologies—i.e., standard image formats for scanned images, commercially available computers supporting high-resolution graphic display, and established national and local networking infrastructures. If the current project proves successful, a grant will be requested to expand the project to additional land-grant universities (P. Q. J. Andre, personal communication, October 5, 1989).

These and other projects (see, for example, Plassard, 1989) are utilizing and experimenting with technology that is more complex and varied than that to which document delivery librarians have ever been exposed. Document delivery librarians who have only had to use technology such as TWX or OCLC to verify and/or submit requests to other libraries will be required to use advanced technologies to communicate and interact directly with individual requesters, publishers, producers of hardware and software, and others. Plassard states that "the role of librarians may, however, be substantially modified; they may need to be involved in software design, in data base development and creation, and in broader aspects of communication" (p. 8).

Examination and adjustment of organizational attitudes and capabilities and the provision of extensive and innovative training are the keys to meeting these challenges and must begin immediately. As Hacken (1988) suggests:

> A defensive attitude towards automation of either the collection records or of the collection itself might be akin to locking and barring the library door to the express trains of new technology. The freight will roll through anyway. A sacrificial attitude means lying down on the tracks to be run over by the streamliner (being railroaded out of the library?). Perhaps the most reasonable approach is to be an active part of the future, taking the offensive and determining directions in which to lay track for the engines of progress. (p. 491)

The products and processes resulting from these and other new technology projects will have the same effect on the provision of document delivery and collection development as the widespread adoption of photocopiers and OCLC had on ILL and cataloging. One danger is that some libraries will be tempted to rely on these systems to the exclusion of traditional collection development and resource sharing activities; in fact, these systems should augment the collection, not replace it. The success of new technology projects may fulfill Braid's (1988) prediction:

> It seems likely that before the end of this century there will have been a general convergence of various forms of data communication. The key to this will be the ability of ISDN to support many applications. Document delivery will form only a small part of this. It should be possible from a single workstation to be able to scan databases held locally, or remotely, of either bibliographic citations or full text; to order, print or browse documents; to have a teleconferencing facility; to have high definition videotext; and a whole host of other features, all in your own home. (p. 186)

Strategic Planning

Strategic planning, which incorporates both the library's mission and overall goals and addresses the specific needs of document delivery patrons, will be a critical component in meeting the demands of the future. The three most important items to be addressed in strategic planning are multiple level service options, education and training programs, and the role of collection development.

Multiple Level Service Options

As briefly discussed earlier, document delivery librarians who have not already done so will want to evaluate and review their current service options to determine how well they satisfy user demands. A significant part of this evaluation is the determination of true costs. The factors to study include, but are not limited to: use statistics, staffing and communications costs, copyright fees, and actual borrowing charges. In addition, productivity levels and turnaround times, which affect overall service, need to be considered. For document delivery units that have not yet established all of these measures, the first task will be to create mechanisms to collect the data and establish standards by which it will be judged. Based on the study data, surveys of user needs, and an exploration of available possibilities, library staff can determine the most advantageous combination of service options and resources for their operations and patrons.

For example, a library with remote users may establish telefacsimile service as a routine process, but if the majority of requests can be satisfied from the library's collections, the use of commercial vendors may not be needed. On the other hand, science and technology libraries have experienced the most extreme increases in subscription costs and may need to expand significantly the use of document delivery vendors such as Chemical Abstracts, ISI, and the National Technical Information Service (NTIS) in order to obtain the specialized literature required by patrons. In addition, libraries may need to offer an on-demand rush service, the cost of which will either be absorbed by the library or passed on to the patron.

Online public access catalogs offer possibilities for expanding access and service to remote users such as students in dormitories, professors in their offices, farmers at home, and library users across the nation. Each local system can supply a different variety of options and services. The extent to which librarians are able to create and offer multiple level service options will depend on the overall evaluation of user needs and the system's flexibility.

Education

Education and communication will be key elements of successful document delivery units of the future. Document delivery staff will be extensively involved in providing end user training to instruct patrons in the methods for obtaining materials. It is at this point that service options, costs, and turnaround times can be communicated most effectively to patrons to assist them in making responsible choices. Librarians will need training in presentation techniques and interpersonal communication skills in order to implement effectively new procedures, policies, and services. Much of this training will be provided through on the job staff development and continuing education programs which could include presentations by product vendors, by experts in audiovisuals and presentation techniques, by professionals in interpersonal communication skills, and by library managers and administrators. According to Hacken (1988):

> Continuing education will also extend to solving problems and making judgments, since on-the-spot decisions of financial importance will need to be made on a daily basis: "In contrast to the present situation where a library will commit a high proportion of costs well in advance and within an extended time frame, decisions on the value and cost of information will increasingly be made at a terminal, with the decision to buy resulting in immediate expenditure. The effects on existing accounting systems will be substantial. (pp. 489-90)

Computer literacy and technical skills are other essential educational elements. Librarians and staff will be expected to use personal computers, laser printers, CD-ROMs, modems, scanners, various software packages, and telefacsimile equipment, as well as to understand the terminology and theoretical processes of automation. Patrons may range from those who are unskilled to those who are very sophisticated. Librarians will be required to quickly determine the patron's skill level and communicate instructions appropriate to that individual. This is critical for a successful transition from manual systems to an automated system. This changing role for librarians was validated by Morton (1987): "Unless they become functionally literate with computer and associated technologies and identify structures for technical support, they will be unprepared for the introduction of technology. If unprepared, they will do themselves and their patrons a disservice" (p. 81).

Collection Development

In order to address changing mandates, spiraling subscription costs, inadequate budgets, and increased user demands, the links between collection development, acquisitions, and document delivery will be evaluated and restructured. Circulation and collection usage statistics will become more critical and have greater influence on purchasing, processing, and retention decisions. For cooperative collection development agreements to be successful, retention responsibilities and assignments, and the special requirements of filling and/or referring document delivery requests will need to be addressed. Most discussions of acquisitions and document delivery center around the costs of acquisition versus the costs of document delivery. Acquisition departments can quote subscription, processing, binding, and preservation costs. "Why do you need a subscription when you can borrow it for free?" is the frequently heard argument. However, document delivery librarians are aware that free is never really free. Staff time, online searching time and costs, copyright fees, and other expenses need to be added to any specific fees charged for the document to obtain the true cost of the transaction. It is *this cost* [italics added] that must be compared to the cost of permanent ownership. Furthermore:

> A library with an established need in a given area of research can never assume that the "other guy," particularly a for-profit vendor, will continue to fill those patron needs in perpetuity. The only guarantee of access is ownership: "Access always presupposes or depends on ownership—by some party." (Hacken, 1988, p. 489)

Collection development, reference, and bibliographic staff devote a significant amount of time and energy to selecting materials that are likely to meet current needs as well as additional needs dictated by changing mandates, new research initiatives, and resource sharing responsibilities. Decisions may be affected by budget limitations, housing and preservation costs and the popularity of unanticipated "hot topics." Collection development programs are basically an attempt to anticipate all patron needs for all times—an impossible task. Adams (1986) states that: "Needs will be increasingly met from direct acquisition at time of request, rather than purchase in anticipation of demand" (p. 97). Hacken (1988) supports this position with the premise that:

> Librarians will not be as concerned with guessing at what patrons might want to use in the future as with finding a way to supply what they do want to use immediately. Collection budgets will gradually reflect the transfer from predemand stockpiling to on-demand delivery....Interlibrary loan and acquisition functions will merge as materials are requested directly through a computer terminal. To the extent collections become less composed of physical holdings and more of electronic storage, the entire library will resemble more and more one conglomerate ILL department. (pp. 488, 491)

Entrepreneurial Attitudes, Values and Practices

As stated earlier, librarians will be increasingly overwhelmed by the scope and complexity of demand. In order to survive, libraries will want to incorporate and adopt more entrepreneurial attitudes, values, and production practices, including outreach and marketing. As Hacken (1988) observes:

> We who do the jobs of collecting and connecting will always be needed: even if patrons know all about databases and own or lease a number of them, they will

> look to a research collection for those items too numerous or too expensive to buy. Patrons will look to us increasingly for online access, software, interactive videodiscs, or for whatever else they either cannot afford or are unable to find on the public marketplace. (p. 491)

Historically, the inherent value of library collections has been overlooked by librarians whose attitude has been one of collection building and maintenance rather than marketing. White (1988) has commented that:

> Commercial providers...compete for the privilege of supplying needed materials. Major academic libraries, with access to infinitely larger collections, could do it not only better but also faster because they have much more under one roof, but they don't encourage the process because they see no incentive for themselves. (p. 44)

As the emphasis shifts from ownership to access and library staff recognize the interdependence of libraries, the service benefit (which may be interpreted by some libraries as "profit") and the value of their collections as marketable resources, a more businesslike attitude is evolving. Libraries will need to adopt operating practices and standards similar to those of a for-profit corporation. A more entrepreneurial environment may be created by using the strategies in the next three sections as a guide.

Managerial Transition

Historically, document delivery units have been part of reference, circulation, or other library units and were supervised rather than managed, resulting in little or no autonomy. Library organizations will need to be redesigned to be more responsive to user needs and adaptive to changing climates. In order to meet this challenge, future libraries should develop new support mechanisms to encourage document delivery units to establish more productive connections with other library units and develop greater independence and more businesslike operations. The following approaches will assist organizations in making this transition:

1. bring in consultants to analyze and advise;
2. develop policies and practices which address all levels of user needs;
3. instill a businesslike savvy in managers and staff by developing their skills in:
   —forecasting and predicting change in volume, scope, use, attitudes, etc.
   —budgeting and cost analysis
   —alternative methods of staffing
   —innovative procurement methods
   —user surveys and usage statistics
   —techniques of supervision and management of resources (e.g., personnel, collections and funds);
4. consult and inform document delivery staff about new initiatives and technological innovations, including research and development;

5. create and/or expand "continuing staff development" and other training programs;
6. develop and use high quality meaningful graphs, charts, and statistics;
7. create mechanisms for dealing with copyright laws, guidelines, and developing issues;
8. contribute to the development of document delivery standards by working with NISO (National Information Standards Organization—Z39) and other professional groups;
9. develop cooperative agreements with local, state, national, regional, and international libraries and networks;
10. encourage professional development through organizations such as ALA (American Library Association), SLA (Special Libraries Association), IAALD (International Association of Agricultural Librarians and Documentalists), CGIAR (Consultative Group on International Agricultural Research), FAO, and others.

Product and Service Reappraisal

"Document delivery is for many organizations a *business* [italics added] in the true sense of the word. Even librarians, some of which [sic] have traditionally provided free ILL services on a reciprocal basis, are increasingly seeking to maximize their revenue form [sic] such activities" (Wood, 1988, p. 150). Libraries have a responsibility to provide a quality product which will meet user's needs. In order to meet this responsibility, the following need to be established:

1. superior quality products;
2. multiple service level options and time frames that meet optimal efficiency and cost effectiveness;
3. production line processing of 80 percent of all document delivery requests; and
4. appropriate costs.

Marketing and Outreach Campaigns

The adoption of the following marketing and outreach programs and activities will complete the strategy for creating a more businesslike environment:

1. market products and services through advertisements, newsletters, brochures, and other means;
2. establish responsibilities to the institution, the library community, and others as appropriate (including network and resource sharing partners);
3. identify additional products and clients through market surveys;
4. assist other libraries by sharing strategies, products, and other ideas and materials.

Networking and Resource Sharing

Adoption of any or all of the suggestions presented will result in improved service by document delivery units. However, the establishment of stronger, more formalized networks and resource sharing agreements will enhance *every* library's ability to provide premier service. Networking should begin at the lowest possible denominator and continue upward to the national, regional, and international cooperative levels.

National. Lacking a national network, agricultural libraries will benefit by establishing agreements for provision of document delivery services to each other. These agreements may serve as the basis for the creation of a formal network with prescribed referral mechanisms and address such issues as products and services, collection and resource sharing responsibilities, costs, billing, and turnaround times. The creation of union catalogs, expansion of AGRICOLA and OPACs to include the holdings of other agricultural libraries, and development of other bibliographic and location tools such as the soon to be published "The World List of Agricultural Serials" (a cooperative project of NAL and CABI), may encourage the development of this type of network activity.

Where a national network exists, the premier agricultural libraries should make every effort to assist smaller agricultural libraries to become active participants and thereby gain the benefits of national cooperation. The newly formed United States Agricultural Information Network (USAIN) is an association of librarians and others working in the field of agricultural information in the United States. This organization will provide a forum for the discussion of agricultural information issues and may provide a mechanism for the development of a formal U.S. agricultural document delivery network (for more information see Thomas, 1989).

Regional. The creation of regional networks depends on the existence of strong national networks. Scandinavian libraries have established a regional network. Denmark, Finland, Norway, and Sweden each maintain their own national activities such as shared cataloging and union catalog production. In addition, automated document delivery location and ordering systems have been developed to increase cooperation across national borders (Winkel, 1988). An example of a developing regional network is that of the libraries in Southeast Asia. Within that region, microfiche of regional holdings of nonconventional documents, union lists of serial holdings, surveys assessing document delivery problems, and pilot projects for coupon schemes have been created or implemented (Agha, 1987). Library and information networks such as AGINFONET-SEA (Agricultural Information Network for Southeast Asia), NFIS (Network for Fertilizer Information Systems), and APINMAP (Asia-Pacific Information Network for Medicinal and Aromatic Plants) have proliferated to overcome economic, political, social, and cultural factors which previously hindered developments in resource sharing (Gregorio & Sison, 1989).

International.

Samaha (1987) presents an excellent overview of the elements necessary for the creation of an international network:

> An international cooperative solution to document delivery presupposes that cooperation is effective at the national level. Developing countries cannot rely only on international or bilateral assistance; they need to allocate a certain amount of resources, and to set up and improve all feasible internal mechanisms for document delivery. Among the requirements or actions, the most important are:
> —the existence of a minimum core collection of foreign periodicals;
> —the coordination of acquisitions in order to optimize the use of existing resources;
> —the preparation and updating of the country's union list of periodicals;
> —the establishment of a national mechanism for inter-library loans, photocopying and microfiche services;
> —to encourage authors in the country to automatically send reprints of their articles or publications to the AGRIS centre;
> —to train and encourage users to request reprints from authors when affiliation is indicated in the AGRIS record and to deposit a copy in the AGRIS centre. (p. 105)

Two examples of successful international networks are AGLINET and AGRIS: AGLINET (AGricultural LIbraries NETwork), a voluntary association of twenty-seven agricultural libraries and information centers, is the closest approximation to a formalized international agricultural document delivery network in existence. The member libraries have agreed to provide each other with priority interlibrary loan and reproduction services (normally without charge) and to share bibliographic products to enhance location/referral services. The trend has been one of steady slow growth and more libraries are expected to join in the future.

AGRIS is a worldwide network of national, regional, and international centers which contribute bibliographic citations for agricultural materials published within their own country or region. As pointed out by Agha (1987), AGRIS has the potential of becoming an effective document delivery network if the participants accept the responsibility for providing document delivery service for the materials that each catalog and index. The acceptance and implementation of a workable coupon scheme may encourage participants to accept this responsibility and therefore develop this network to its fullest potential. Another alternative, albeit an expensive one, is for the agricultural libraries in developed countries who are considered net lenders (i.e., those libraries who loan more material than they borrow) to accept a societal obligation and assist agricultural libraries in developing countries to provide essential information to their users. This may take the form of support of a coupon scheme or even provision of "free" document delivery service to libraries in developing countries.

In addition to the earlier mentioned networks, two organizations will continue to facilitate the establishment of cooperative agreements among libraries of all sizes and types throughout the world. The International Federation of Library Associations and Institutions (IFLA) provides leadership in international cooperation and document delivery. To assist in this effort, IFLA has created the Office for International Lending which encourages standardization of procedures and uniformity of service. The second organization is the International Association of Agricultural Librarians and Documentalists (IAALD) which was founded in 1955 to promote, nationally and internationally, agricultural library science and documentation. Its publications and conferences continue to serve an important role in providing information to, and promoting communication among, agricultural librarians.

CONCLUSION

"Where we have thought of *collections* [italics added], we must think of *connections* [italics added] as the library's means for making material available" (Lacy, 1985, p. 329). As libraries depend increasingly on obtaining documents from other sources, it is clear that systematic planning, at the organizational, local, national, and international levels, must be revitalized. Network oriented collection development and resource sharing agreements will enable librarians to build strong specialized collections and improve access to the world's literature. Entrepreneurial attitudes, values, and practices will encourage strong growth in products and services to keep pace with the rapidly changing environment. However, it is the merger of these two concepts, directed by the leadership of proactive librarians and organizations, that will result in the growth and success of agricultural document delivery. There is no doubt that technology will be a vital link in this effort.

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Agricultural Reference Services

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ABSTRACT

REFERENCE SERVICE PROVIDES the mechanism by which the user of agricultural information can interface with the larger body of knowledge to secure what is desired. Depending on the type of library or information center, that service may range from the provision of the desired information to the training and educating of the user to identify and locate what he/she needs. Technological advancements have greatly improved the accessibility of the broad range of information relevant for the field of agriculture and have many implications for the achievement of successful reference.

INTRODUCTION

One approach in dealing with the multifaceted topic of agricultural reference service is to organize the discussion by types of agricultural libraries. The four main types of agricultural libraries are: governmental and/or national libraries; academic libraries; private sector libraries; and information centers (including international centers). This approach will help fulfill the purpose of this article which is to survey the variety of libraries and information centers in which agricultural reference service is given, to show how reference varies in each, and to indicate what trends in reference service are occurring. Because agricultural libraries vary greatly according to the organizations they support as well as the countries in which they are located, this survey will highlight only the major issues and trends encountered by agricultural reference librarians. Some of the issues and trends to be addressed are

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those affecting user education, bibliographic searching, communications, collections, and staffing. Before the reference trends in these types of libraries are discussed, a brief consideration of reference service and the reference librarian is appropriate.

THE REFERENCE LIBRARIAN

As will be discussed in more detail later in this article, reference librarians provide a great variety of services for their patrons. Depending upon the size and mission of the library, these services may include: providing factual information; retrieving bibliographic citations; interpretation (advice and counseling as an information expert); teaching (also known as bibliographic instruction or user education); selective dissemination of information (SDI); liaison with user groups; and many other related tasks, depending on the needs and the resources of the organization.

What are the qualities of a good agricultural reference services librarian? There are at least three main attributes: subject knowledge of agriculture; an understanding of agricultural information and librarianship (and its new technologies); and possession of the interpersonal skills to deal successfully with clients. Extensive subject expertise is most important in a situation where the librarian prepares subject reports for users—for example, in a special corporate library or documentation center. Subject knowledge is also important for understanding and interpreting the information needs of agricultural clients.

The second attribute, an understanding of agricultural information and technology, is vital. One of the aspects of agricultural reference service that makes it a challenge is the incredible diversity of the field's literature. It is one of the more interdisciplinary fields cutting across virtually all of the sciences, both applied and pure, plus technology and the social sciences (Frank, 1987, p. 294). And as Garfield and Weinstock (1977) imply, the term *agriculture* describes the mission rather than any approach taken by agricultural scientists (p. 278). In dealing with agricultural literature, therefore, one must also be familiar with the larger body of scientific literature.

The new and rapidly changing technologies used to manage, identify, and access the literature are dramatically altering the way in which reference librarians do their work. Today's successful agricultural reference librarian, therefore, should have a grasp of the many technological trends discussed in this issue, and then be able to apply them to his or her particular situation. This is not an easy task since virtually every agricultural library situation will have its unique features including a spectrum of client needs and demands.

The third attribute needed by the reference librarian, interpersonal skills, is one that is often underrated (Hinckley, 1982, p. 85). To perform reference service well, an agricultural librarian should be a good listener and a skilled, yet gentle, inquisitor in order to perform the "reference interview"—a brief but important interview or consultation used to determine exactly what the patron needs.

National Libraries

There is no international norm by which different countries develop and organize their "national" or major regional libraries. Collection development and document delivery, for example, rather than reference service, seem to be the major areas of emphasis in many national and regional libraries outside of the United States.

In the United States there are three national libraries: the Library of Congress (LC), the National Library of Medicine (NLM), and the National Agricultural Library (NAL). LC is the largest library in the world with the legislated mandate to serve Congress. As the U.S. copyright deposit library, it receives two copies of all American imprints; materials for the collection may be selected from these. As the largest national library, it plays a leadership role in many areas of American and world librarianship. The NLM's collection and services address the needs primarily of the medical community while the NAL is mostly concerned with the agricultural community. The NAL contains the premier agricultural collection in the United States and is one of the largest agricultural libraries in the world (Wortman, 1984). Although many users of this library are the employees of the United States Department of Agriculture (USDA), the NAL provides a number of important reference services for other user groups.

The NAL's development of its computerized database AGRICOLA (AGRICultural On Line Access) has significantly affected agricultural reference all over the world. AGRICOLA is actually a family of databases consisting primarily of bibliographic citations to monographs, government reports, and journal articles selected from approximately 5,000 serial titles. The database includes records for items cataloged or indexed since 1970. It is available through several commercial sources including Dialog Information Services and Bibliographic Retrieval Services (BRS), and, since 1988, this major agricultural database has also been available on CD-ROM.

The public services staff at the NAL also produces the "Quick Bibliography Series"—printed results of various AGRICOLA searches having a broader interest group than just one individual or research group. "ALF" (Agricultural Library Forum), the microcomputer-based electronic bulletin board system, was introduced in late 1988. It "provides electronic access to information about NAL products and services and serves as a focal point for networking activities for those who dispense and use agricultural information" (Pisa, 1988, p. 1). In addition to traditional networking activities, the system can be used to exchange software programs and text or data files between callers.

In recent years the NAL has established several specialized information centers as another approach to fulfilling the reference needs of the users. The NAL established these centers to "provide enhanced services to its current clientele as well as to develop new service relationships with the public and private sectors" (Frank, 1988, p. 1). The information centers serve educators, consumers, and the private sector in addition to the traditional primary user of the NAL, the agricultural researcher.

NAL has the largest agricultural collection in the United States; consequently, document delivery is a major activity. The NAL, a "library of last resort," supplies copies of agricultural publications not available from any other source (Wortman, 1984). Monographs may be loaned, with restrictions, both in the United States and abroad, and an extensive photoduplication service is offered.

In 1987 a user fee policy for reference assistance was established to apply to users outside of the USDA ("NAL Establishes," 1987). A threshold level of information support services, beyond which a fee is charged, was established—i.e., one hour of staff time or $25 in computer usage costs. Some categories of users (e.g., USDA staff, congressional and White House staff, other federal staff, and recipients designated by legislation) are provided with a full range of reference services without charge.

Agriculture Canada is the agency of the Canadian government concerned with the agricultural needs of that country (M. C. Cutler, personal communication, August 1, 1989). There is a central Agriculture Canada library in Ottawa which maintains the largest and most general agricultural collection. Approximately thirty branch libraries are located throughout Canada. The central library provides leadership in a number of ways which affects the reference services supplied to the users who are primarily Agriculture Canada staff members. They maintain an online union catalog for Agriculture Canada to which the branches provide cataloging and access via Datapac, a telecommunications network. The Canadian Department of Agriculture translations service is coordinated through the central library and is available to all department employees. Online commercial bibliographic, full-text, and numeric databases are searched, and several CD-ROM files are available in this library. The central library is in the process of developing charge-back programs for direct costs such as commercial online searching and cost sharing for the routing of current journals.

The branch libraries are funded locally, except for the staff, and the collections reflect more the areas of interest of the local department personnel. The major part of the budget is allocated for journal subscriptions. Networking is necessary for the execution of reference because the reference collections are quite small compared to the central library. User education is conducted, primarily on an individual basis, to assist the user in using the collection independently. Bibliographic database searching is done, but CD-ROMs are limited at the branch libraries. An internal electronic system is used to communicate with users, but telefacsimile machines are not used extensively. Nondepartmental staff are free to use the collection but mostly on an in-house basis.

A final example of a large national agricultural library is one in the Soviet Union. In the Ukraine, the Central Scientific Agricultural Library in Kiev at the Southern Branch of the Moscow-based All-Union V.I. Lenin Academy of Agricultural Sciences is one of the oldest specialized libraries in the Soviet Union. It serves as the scientific and technical center for the Ukrainian agricultural libraries network (Tselinsky, 1982). The network consists of research institutes, experiment stations, and educational institutions providing agricultural information throughout the region. The information and bibliographic activities are diverse and include the publication of current and topical bibliographies, compilation of new book lists, preparation of information publications, arrangement of book exhibitions, and the organization of "specialist's days" and "information days" programs to help satisfy the information requests of scientists and practical agriculturists and for publicizing scientific achievements and agricultural progress.

Academic Libraries

The organization and type of reference services in academic libraries vary greatly from one institution to the next depending upon the mission of the institution as well as budgets and academic department politics. In the United States, the state land-grant universities are normally the institutions with the mission to conduct agricultural research and extension. Either a branch or departmental library dedicated to one or more aspects of agriculture will exist, or the library support responsibilities will be assumed by a science library or a centralized library.

Two examples of branch agricultural libraries are those at the University of Kentucky and the University of Wisconsin, each with its own staff and collections. At such branch libraries the services might include reference, interlibrary loan, acquisitions, cataloging, and the circulation of materials. The collections are often broad enough to serve a spectrum of agricultural faculty and students—from the needs of research faculty to the class assignments of undergraduates. The subjects covered in the collection may need to encompass such diverse research as forestry, entomology, soil science, or agricultural economics. If the budget is limited, or if there are other departmental libraries, the agriculture branch may include only a core collection.

An alternative to the branch library model, the centralized concept of library organization, has developed in a number of U.S. academic libraries. There is some evidence that this model may be gaining in favor as universities attempt to economize due to reductions in academic budgets, the soaring costs of library materials, and the attempt to make the maximum use of library staff (Olsen, 1979). One disadvantage of the centralized model is that it does not offer the convenience of access of a branch library located in or near the agricultural departments. The centralized library concept, however, does offer greater economy by not having to duplicate materials and by not having to staff a branch, or branches, with additional personnel. Another advantage of the centralized model is the convenience of having all of the collection in one facility. This eliminates the need for the user with increasing interdisciplinary interests to go to several places to locate the desired information.

A number of universities, including Texas A & M, Iowa State, and Oregon State have consolidated library services, providing their agricultural reference services from a central reference desk that also handles the reference needs of many other subject areas. It is common, and desirable, in a centralized scheme of libraries, to have a reference librarian dedicated to providing expert assistance in the area of agricultural reference. In many libraries the agricultural librarian is also in charge of collection development activities.

The technological changes occurring in academic reference services today are dramatic and are revolutionizing the way in which librarians serve their clientele (Fisher et al., 1987; Saffady, 1989). In the 1970s the advent of online bibliographic searching allowed the reference librarian to search through hundreds of thousands of bibliographic citations in such computerized databases as AGRICOLA, AGRIS, and CAB Abstracts (Frank, 1987, pp. 301-07). Online services have traditionally required the mediating assistance of a librarian or information specialist due to the complexities and varieties of searching protocols utilized by the wide number of databases. Since the introduction in the early 1980s of more user-friendly online searching software packages and lower evening rates, many patrons have been able to perform their own searches (Kesselman & Watstein, 1988). These packages also allow reference librarians with little online training to perform simple, quick, and low cost searches at the reference desk. Such ready reference searches are usually limited to only a few references, normally done to verify questionable or incomplete citations or to find the patron a few references on a specific subject (Brownmiller et al., 1985). The power of online database searching is not only speed, but the flexibility to perform keyword searching and the ability to link a number of terms. This may result in some retrieval of irrelevant citations but also allows the searcher to retrieve citations that would be very difficult to locate using a traditional hardcopy index.

The latest generation of technology that has the world of reference services in a stir is the CD-ROM (Compact Disc-Read Only Memory), with discs that have a storage capacity of as many as 275,000 printed pages. Many academic reference divisions have discovered the immense popularity of CD-ROM stations with their clientele (Starr & Butcher, 1988). While sitting at a personal computer connected to a compact disc player, users in a few minutes, can teach themselves the rudiments of performing a search through hundreds of thousands of bibliographic records in a database such as AGRICOLA. Not only are the results of such a search immediate, in most libraries they are cost free to the user. Another advantage for many clients is the fact that they are in charge of their own searches (Taylor, 1989, p. 454). This sense of empowerment is exciting for many users who once dreaded the task of searching through dozens of volumes of printed indexes that were often not designed with the inexperienced user in mind.

The advent of CD-ROMs in the library is changing the nature of reference work in ways other than end user searching. If patrons discover that their library does not have the materials referenced in the CD-ROM, then the interlibrary loan office may be requested to obtain them from another library. The increasing demand for interlibrary loans in many libraries seems to be directly linked to the use of CD-ROM bibliographic database stations (Taylor, 1989).

Another bibliographic tool has emerged at the reference desk of many university libraries in the past few years. Online access at the reference desk to major bibliographic utilities, such as OCLC (Online Computer Library Center, Inc.) and WLN (Western Library Network), makes it possible to verify bibliographic citations in one or two minutes rather than the many minutes (or hours) sometimes required by a manual search. Besides speed, these kinds of utilities also allow more flexibility in searching. One can search by author, author-title, title, ISBN, and other fields. But, like the introduction of CD-ROM stations into the library, the use of these bibliographic utilities has increased the load on interlibrary loan offices. More patrons are taking advantage of these utilities, and the result is that those larger libraries which are members of the utilities are experiencing many more requests for loans. Some of these libraries in the United States find that they are lending more materials than they borrow (i.e., are net lenders). Many are raising their lending fees or are asking to be removed from the holdings records in the utilities in order to reduce the volume of requests. These choices will make it more difficult for resource sharing, particularly for those researchers who are trying to locate specialized materials that are held only in a handful of the larger libraries.

In most academic libraries an important component of reference service is teaching patrons how to use the library and its resources. This process is called bibliographic instruction (BI) or user education. BI has two main functions: first, to allow patrons to find information on their own; and second, to reduce the number of simple repetitive questions at the reference desk (Freides, 1983, pp. 459-61). Traditional methods of doing BI are giving formal classes on the use of the library as well as conducting library tours.

A "user friendly" reference area is created by many libraries to help decrease the number of repetitive questions. Some of the ways this is done are: arranging and labeling the reference area and materials as logically as possible; providing good signs and floor maps in prominent locations; making handouts to explain the use of indexes, catalogs, and other library tools; using expert systems; and using audiovisual media (such as slide/tapes, videotapes, self-guiding cassette tapes). Although these kinds of materials are generally aimed at the undergraduate student, faculty and graduate students might be provided with more technical handouts or in-depth seminars on specific topics (e.g., AGRIS online; the use of Boolean logic in computer searches; the grey literature of agriculture) by the agricultural reference professional.

Another duty of the agricultural reference librarian might be providing current awareness service, also called the selective dissemination of information. In consultation with faculty or other researchers, the librarian develops search "profiles" to retrieve new relevant citations as they are published. Using these profiles, the librarian searches the agreed upon databases on a regular basis (e.g., monthly or quarterly) and then sends the results to the faculty member. The profile can be adjusted as needed, can be input by the librarian each time the search is run, or can be stored electronically—an efficient and consistent method. Some libraries offer a document delivery service whereby the faculty member may request delivery of copies of the desired articles or books. Due to lack of staff and the time and expense required for this type of service, many university libraries charge either full or partial costs. Recent innovations in electronic delivery of information also have affected document delivery in the academic library. The acceptance and expanding availability of electronic mail and telefacsimile services have caused new demands as well as new possibilities for the communication of information.

Private Sector Libraries

Private sector libraries serve a much smaller user community than either national, regional, or academic libraries. Usually the user group is limited by employer, but some private sector libraries will provide limited reference service to people outside of the company. The scope of the reference services provided is also considerably different.

One example of a company in the United States with an agricultural information center is Cargill, Incorporated, a multinational agricultural corporation. Cargill's Information Center is located at the corporate headquarters in Minneapolis, Minnesota, and serves only the employees of the Cargill company, with managers being the primary users (J. Peterson, personal communication, July 17, 1989). Various user education activities are undertaken to market the information services available. They include general classes, participation in the orientation programs for new personnel, and presentations to the different departments and divisions. However, no instruction on how to use the collection is offered. Requests are accepted covering any topic as needed by company personnel. The answer is researched by the staff, whether it be a bibliographic citation or list of citations, a market figure on a particular crop, or a detailed report including extensive data, citations, government regulations, and other information. The center's collection is consulted, automated bibliographic and/or textual databases and wire services are used, and, if necessary, fee-based information services are utilized. The information is then analyzed and the entire compilation is provided to the requester. Telefacsimile and the Cargill Communication System, a worldwide company electronic mail system, are used extensively to communicate with the users of the Information Center's services. A charge-back program, including both direct and indirect charges, is used to cover the entire budget of the center.

The American Farm Bureau is a trade organization in Chicago with an affiliation with every U.S. state farm bureau (S. J. Schultz, personal communication, August 1, 1989). The library contains a very small collection so the staff rely heavily on networking and other libraries, particularly a nearby public library and Illinois state universities, to meet the needs of the users. The clientele consists of primarily farm bureau staff from the central office or from the different state offices. There are few walk-in users and an in-house electronic mail system and telefacsimile are used extensively. Commercial online bibliographic and full-text databases, including reference sources, are used as needed. There are currently no CD-ROM files available in the library, but there are plans to acquire census information in that format sometime in the near future. Information requests from nonemployees are accepted, but normally no more than thirty minutes will be spent locating the information, and fee services, such as online searching, will not be used for these requests. Referrals to other sources of information are provided. The library is funded centrally and does not charge for its services.

The reference services of two different libraries within Pioneer Hi-Bred International, a corporation in Des Moines, Iowa, vary considerably. The corporate library, serving primarily management personnel, provides mostly ready reference (G. T. Rolofson, personal communication, August 1, 1989). Commercial online databases, as well as full-text, bibliographic, and data files, are utilized by the staff to answer reference inquiries. Agribusiness USA, a commercially available database, was developed at Pioneer, and is still maintained by information services staff, and is used extensively by the corporate library personnel. An in-house online catalog is available throughout the organization. Both bibliographic and data files are available in the library in CD-ROM format. Communication with employees outside of the immediate facility is achieved with an in-house electronic mail system or telefacsimile. The corporate library is funded by a combination of a charge-back program and a centrally-funded budget.

In contrast to the corporate library, many of the staff in research are regular visitors to the plant breeding library (H. Hoeven, personal communication, August 1, 1989). Orientation and training are conducted on an individual basis to assist resident researchers in becoming independent users. Manuals containing explanations on how to use different library materials and the online catalog, as well as information on various services, are maintained within the library. Overviews of library services are presented to different groups within the corporation. No CD-ROMs are currently available, but online bibliographic databases are accessed. Occasionally the reference collection at a nearby university library is utilized. Pioneer has a part-time employee at the state land-grant university who has access to the reference collection there and, in response to electronic mail requests, provides document delivery to the corporation researchers. Commercial vendors are sometimes used for document delivery, particularly for patents. Telefacsimile is not used extensively. The plant breeding library also serves clientele at forty to fifty locations throughout the United States although many might also use a nearby academic library. Most of the library's budget is funded centrally, and there is limited use of fees for services provided. This library will accept reference inquiries from nonemployees, but most relate to Pioneer company activities.

AGRICULTURAL INFORMATION CENTERS

Agricultural information centers tend to focus on a specialized and, frequently, extremely narrow area of interest. A wide range of information services is offered to the users who may be affiliated with the organization or, in some cases, might be from a world community. Many of the world's agricultural information and documentation centers will be listed in the forthcoming IAALD (International Association of Agricultural Librarians and Documentalists) sponsored publication, *Agricultural Information Resource Centers: A World Directory*. Some of the information services available at a selected few centers are noted below as examples of the kinds of services that might be expected of a specialized information or documentation center.

The Central Tobacco Research Institute (CTRI) Library for Tobacco Information Services in Rajahmundry, India, maintains a subject file of indexed articles on tobacco and other related subjects for ready reference (Rao & Suryanarayana, 1988). The library provides an inquiry service for answering technical questions. Many data are acquired and maintained to assist in this service including, for example, the latest world tobacco statistics, information on Indian tobacco cultivars, and statistics on the production of tobacco in Indian states and elsewhere. Reference guides are developed on specific topics such as the chemical constituents of tobacco, fertilizers, soils, and the pests and diseases of tobacco. Bibliographic searches are performed regularly as requested by the scientists, and bibliographies are prepared. Library staff members also compile collections of articles with abstracts on current research problems in key areas. Reprints received in the library are accessible through an online file and a monthly accessions list is available. Papers, bulletins, directories, and other materials are published by the library professionals. Training in the utilization of library resources and in writing technical and scientific articles is conducted in the library for new scientists at the institute and outside research workers.

At the Visayas State College of Agriculture in Baybay, Leyte, the Philippine National Root Crops Information Service (PRIS) analyzes the literature covering a closely defined group of crops of particular local interest (Broadbent, 1987). PRIS acts as a link for information flow among agricultural decision-makers and planners, the scientific community, farmers, and extension personnel. This information service is able, assisted by its link with other specialized information services at the major international agricultural research centers such as the Centro Internacional de Agricultura Tropical (CIAT) and the International Institute of Tropical Agriculture (IITA), to analyze the pertinent literature, provide state-of-the-art reviews and technical reports of significant developments, and put the farmer in contact with the scientist through a system of information analysis. Scientific inquiries which the staff are unable to answer immediately are directed to the most appropriate institution or individual, locally or abroad, through an inventory of root crop scientists.

The Centre Technique de Cooperation Agricole et Rurale (CTA), headquartered in Wageningen, The Netherlands, was established in 1983 and is financed by the European Development Fund. It facilitates and ensures the exchange of existing scientific and technical information particularly between the European Community and sixty-three African, Caribbean, and Pacific states. Many activities are supported (e.g., conferences, seminars, studies, publications, and translations), but one very specialized activity is a question and answer service (Niang, 1987). The users include students, researchers, international organizations, teachers, farmers, agricultural extension staff, and others. Questions received by the service cover a broad range of subjects.

The library at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Patancheru, Andhra Pradash, India, publishes the *Library Services Bulletin,* a monthly which features news of library developments, services provided, and a list of the publications added during the previous month ("Library," 1987). A quarterly publication listing selected forthcoming conferences on agriculture and related sciences is produced to alert the ICRISAT scientists of important meetings. A selective dissemination of information service, based on current journals received at ICRISAT and a few selected abstracting journals, is offered to scientists at ICRISAT and at relevant national, regional, and international centers in the semi-arid tropics. Abstracts of relevant papers are routed within a month of their receipt to the library. Photocopies of articles requested as a result of the SDI are provided. It was reported in 1987 that automation of the SDI service was planned and would be expanded to include subsets of the CAB and AGRIS databases in all five of the crops mandated to ICRISAT. These, together with local input, would comprise the SATCRIS (Semi-Arid Tropical Crops Information Service) database. User interest profiles would be matched monthly against the updated database. Comprehensive literature searches, including online database searching via DIALOG, are done on demand.

The Agricultural Research Information Center of the Indian Council of Agricultural Research (ICAR) in New Delhi has collected, compiled, and stored research project files for ongoing and completed projects in agriculture, animal husbandry, and fisheries for dissemination in mimeographed form (Reddy, 1987). Information on the research activities of about 5,000 agricultural scientists is maintained by the center and lists of research personnel are published periodically. Computerized SDI printouts, based on AGRIS magnetic tapes, have been offered since 1987. Another ICAR library, the Indian Agricultural Statistics Research Institute in New Delhi, maintains a complete file of field experiments and publishes research summaries.

The Information System for Agriculture, the Fachinformationssystem Ernahrung, Land-und Forstwirtschaft (FIS-ELF), is a national network in the Federal Republic of Germany (Haendler & Laux, 1986). The Zentralstelle fuer Agrardokumentation und-information (ZADI) in Bonn acts as the coordinating center. Twenty-one documentation centers, each responsible for a special field of agriculture or related area, belong to the network. The documentation centers record and index the literature relevant to their special fields. The centers offer different kinds of information services to users, but conducting bibliographic searches in both German and foreign databases in response to special user questions has been one of the most used services. The SDI service is available on a monthly or quarterly basis. The centers offer individual services based on their own databases. They might provide printed materials to inform users about current special topics or special bibliographies. A very specialized service of one of the centers, the Center for Animal Production, is the publication of feed composition tables for different kinds of animals. Some of the documentation centers are connected with a special library which collects the items indexed. In most other cases the document delivery needs can be served by other German libraries.

The International Maize and Wheat Improvement Center (CIMMYT), an internationally funded nonprofit agricultural research and training organization located in Mexico City, established the Scientific Information Unit (SIU) in late 1984 as an integral part of CIMMYT's information services (Hesse de Polanco, 1985). Specific activities of the three major components of the SIU include delivery of bibliographic services to individuals and institutions in developing countries, a document delivery service, development of local management information databases covering CIMMYT-generated and other relevant grey literature, and the production of state-of-the-art reviews prepared by invited senior visiting scientists and selected CIMMYT staff. *Wheat, Barley and Triticale Abstracts* (produced by CABI), *Wheat, Barley and Triticale Bibliography* (produced by CIMMYT in collaboration with AGRIS), and *Maize Abstracts* (co-published with CABI), are provided free to libraries and collaborators in developing countries. They are available in developed countries by paid subscription. Online searches are performed in the major world bibliographic databases in response to specific requests.

The current awareness services of Centro Internacional de Agricultura Tropical (CIAT) in Cali, Colombia, were developed for applied agricultural researchers in the developing countries of the tropics (Harris, 1985). Other heavy users of this service include persons and institutions that are directly involved in technology transfer, crop production, and agricultural training activities. Various user groups of CIAT were surveyed to determine ways to meet their information needs. The pages of contents service is the most heavily used of the services offered. All of the users participating are notified of every journal article available in CIAT's library regardless of the language, origin of publication, or length. The Cassava Information Center, the Bean (Phaseolus vulgaris) Information Center, and the Tropical Pastures Information Center (all CIAT information centers) have narrow subject scopes and differing methodologies for covering these subject areas, but their current awareness services are similar to the CIAT library's program. Each of the information centers abstracts items received and publishes three compilations of these abstracts each year. Each also offers document delivery services. Requests for literature searches of the information centers' databases are accepted, and specialized bibliographies are available to users. Nonbibliographic reference questions are accepted at the information centers and, if these cannot be answered by the librarians or information specialists, they are referred to a collaborating scientist or to another source of information. The centers' personnel may also be involved in the analysis and synthesis of information for users. They might, in addition, develop reference tools for the researchers, including such items as multilingual thesauri, fact sheets, and articles for newsletters or technical bulletins.

The U.S. National Agricultural Library, as mentioned earlier, has several information centers. The model for these centers is the Food and Nutrition Information Center (FNIC) founded in 1971 (Frank, 1988). In addition to the specialized collection, there is also an active exhibits program. Staff members, including registered dietitians and nutritionists, are often asked to speak and exhibit at various national meetings covering a broad range of topics. The FNIC is a national demonstration center for food and nutrition microcomputer software. Information resources for consumers, educators, professionals, and others are listed on various "pathfinders," specialized bibliographies, or information sheets. NAL has information that centers in the following areas: agricultural

Trade and Marketing, Alternative Farming Systems, Animal Welfare, aquaculture, biotechnology, critical agricultural materials, family, fiber and textile, food irradiation, horticulture, rural, and youth development.

NEW TECHNOLOGY AND REFERENCE IMPLICATIONS

Besides the several new types of electronic reference tools now used routinely in many libraries, there are a number of recent technical innovations being tested. While some of these are being used as reference tools today, others may not be in common use for several years.

A recent addition to the array of electronic tools enhancing reference services is the expert system. An expert system is a sophisticated software program which allows a library patron to be guided through a set of decision-making steps to arrive at answers. The present use of these systems allows the user to interact with a consistent and readily-available tool to answer repetitive questions about such things as public access catalog use, end user database searching, and reference and referral in the library (Travis, 1989, p. 41). Two of the first sophisticated library expert systems were agricultural. The NAL introduced its Answerman system in 1986. Designed for use on a microcomputer, it points users to a variety of agriculture-related reference books and corresponding page numbers (Waters, 1986). A sample component of Answerman is the AquaRef system, an expert advisory system on aquaculture with the capability of being linked to other external programs including bibliographic databases and CD-ROMs (Hanfman, 1989).

Another innovation in optical disc technology is the videodisc—a larger (12 inch) disc than the 5 1/2 inch CD-ROMs with the ability to store and display thousands of images. The videodisc is being used in a number of agriculture-related pilot projects at the National Agricultural Library to demonstrate the medium's textual and graphic storage possibilities (André, 1989, pp. 330-32). The videodisc format has shown great potential for future publication and storage of information since it combines the advantages of compact storage, full-text retrieval, and good image resolution. A number of U.S. land-grant university libraries have cooperated with the NAL in the production of such titles as *Soil Taxonomy*, the *National Corn Handbook*, and the *Fact Book of Agriculture* in this format (p. 330). Another project is the National Agricultural Text Digitizing Project which is testing the feasibility of capturing text and images in digital format for publication on CD-ROM discs. The project began with the production and distribution to forty-four participating land-grant libraries in 1989 of a test disc on aquaculture. The project will continue with a second disc consisting of publications on international agriculture that will be selected by the Consultative Group on International Agricultural Research (CGIAR). This second disc is being supported by the World Bank and the United Nations (p. 331).

These experiments with optical disc technology may revolutionize agricultural reference work. The concept of scanning documents to store their text and images on a disc, then being able to search the text for keywords has dramatic implications for libraries. What directions this new technology will take and how rapidly is not easy to predict. There are a few problems to resolve before the revolution takes affect in most agricultural libraries. At the moment, videodisc technology is expensive and there is some uncertainty about the permanence of the data on the discs. These barriers will probably be removed in the next few years as new technology advances and as commercial interests enter the field to compete for a new market.

Farmers and extension agents are now tapping into a number of electronic information utilities via videotex and teletex. Videotex is an interactive information system in which data are transmitted over telephone lines between a distant computer and a home television screen or computer screen. Teletex allows the home viewer to receive only the information, while videotex allows the viewer to interact with the remote computer in order to select, manipulate, or input information. Frank (1987, pp. 312-14) provides a good discussion of a number of North American agricultural utilities of these types. AGNET (AGricultural NETwork) was a major videotex service developed by the University of Nebraska College of Agriculture in 1975 to offer management models, current agricultural information, and national and international electronic communication. By 1985 it was self-supporting and was accessed by users in forty-seven states and nine countries (Rice, 1985). During the late 1980s this pioneering service began to falter due to a drop in subscriptions (from 1,000 to 600); rising maintenance costs; the introduction of sophisticated programs for microcomputers; and competition from other services ("A Reflection," 1988). Although AGNET ceased operations in December 1988, at least twenty other North American electronic agricultural information services continue to thrive ("Electronic," 1989).

AgriData Network based in Milwaukee, Wisconsin, is a commercial videotex service which offers national and international news, financial information, weather services, commodity information, and other services. The producer, AgriData Resources, Incorporated, has expanded its services into the international marketplace by forming the AgriData Worldwide system through agreements between AgriData Network/Uninet and international carriers who link to public data networks in the user's country ("AgriData," 1985, p. 13). Another service is ProNet (Packer Produce Network) available in the United States and Canada from Vance Publishing Corporation. ProNet contains price and availability information for fresh fruit and vegetable commodities as well as market analyses, general industry news, and weather (Linden, 1985, p. 10). A new entrant into the business of electronic information delivery is Pioneer Information Network (PIN), an online product of Pioneer Hi-Bred International, Incorporated. The producers of PIN intend to keep its service easy to use, responsive, and hope to capture subscribers who formerly used AGNET ("It's Too Soon," 1988). A major information service offered by the USDA is its EDI (Electronic Dissemination of Information) Network, providing reports, weather information, and national as well as international trading data ("USDA activities," 1989). The EDI Network is operated by Martin Marietta Data Systems under contract with the USDA.

This arrangement of the U.S. government to provide agricultural information through private vendors has many librarians concerned that a category of "information poor" farmer may not be able to afford the subscription rates of the "privatized" services (Kranich, 1989). Farmers or other users who cannot afford such services may find assistance from their local public library. Although most public libraries are understaffed and have limited resources, there are cooperative networks that can allow them to tap into the resources and reference expertise of larger libraries. Formal reference networks and cooperative reference programs have been explored and are being used successfully to some extent. The Library of Congress, for example, has established a program of cooperative reference with state and public libraries in order to refer questions to the appropriate library (Hahn, 1981). Other state and regional cooperative services, such as the Slavic Reference Service at the University of Illinois and cooperative online searching in Kansas, are being developed to better utilize the limited resources of libraries (Rettig, 1981; Martin, 1986). MINITEX is an interactive network of academic, state agency, and public libraries in Minnesota, North Dakota, and South Dakota intended to provide reference service to some 200 local libraries with limited reference resources (Dustin, 1988). The NAL's concept of a national agricultural network is still in its inception but someday may be a vehicle to provide cooperative reference services within the United States (Thomas, 1989). All these efforts, however, are limited at this point in time and need to be enhanced.

CONCLUSION

The new technology sweeping the world of information science has had a dramatic impact on the working lives of most agricultural reference librarians. This new technology has helped solve many problems but has also created a number of new challenges. Computers, particularly microcomputers, and better and more plentiful telecommunication systems and equipment, have supported a much greater bibliographic control of the agricultural literature. Increased access to both bibliographic information and to documents themselves, and more rapid delivery of information and documentation have resulted.

For the library clientele, particularly in the academic community, the new technology has enabled users to become truly end users, allowing them in many cases to bypass completely the agricultural librarian to access the automated databases. CD-ROM stations and user-friendly database searching packages permit users to search the literature without the services of an intermediary. In combination with the perception of many users that the librarian and library are barriers between them and their information needs, this capability sometimes misleads users into relying on incomplete information. Librarians need to work with their users to ensure that the use of end user systems does not lead to the acceptance of a myth that those systems are the answer to all information needs. Most of these systems, including CD-ROM, expert systems, videotex, and end user online services, should be seen as just one step in accessing the complex literature of agriculture.

Private sector libraries and information and documentation centers frequently have a strong service orientation. The increased availability of technological advancements allows the staff in these organizations to improve the quality and quantity of the services provided. Although many of the collections of these facilities are not included in any of the cooperative utilities, automation does permit improved in-house bibliographic control. CD-ROMs permit online searching of a broadly based body of literature but are not dependent on the availability of telecommunication systems or the financial resources to access them.

The challenge to increase the sharing of agricultural information, whether through cooperative acquisition programs, last location for specific journal titles in regional agreements, cooperative reference, automated information databases, or other programs, is particularly important in these times of decreasing budgets. Ways must be found to open avenues of cooperation and accessibility in order that agricultural information is shared with those who need it.

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User Needs and Library Services in Agricultural Sciences

BEVERLEE A. FRENCH

ABSTRACT

THIS ARTICLE PROFILES the users of agricultural information and describes their information needs and behavior. It reviews the trends in agriculture and information delivery and the implications of these trends for users and for the relationship between information professional and user. It suggests roles which librarians and information professionals can assume in order to meet agriculturists' information needs.

INTRODUCTION

This article examines the users of agricultural information—their information-seeking habits, their information needs, and their responses to library services. The term *user* is employed to mean an *agriculturist*—i.e., a scientist, a farmer, an extension agent, or any individual involved in agriculture or its products. Every information professional in the agricultural sciences should be concerned with the user who is responsible for the application of information to the practice of agriculture or science.

The agriculturist is the critical agent in the transfer of technology. The central purpose of an agricultural library or information service is to improve agricultural research and practice. It is therefore important for librarians and documentalists to examine the effectiveness of their services and products vis-à-vis the user and to create mechanisms by which they can receive regular feedback. As Drucker (1976) implies in a talk on the public service institution, a library does not exist merely to collect books or even to practice librarianship but to provide information to people. It follows that understanding people deserves as much

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thought and effort as collecting and organizing information. Only by understanding how users obtain and use information can one see how the library or information service fits into the process of information transfer.

This review takes a step in that direction. It focuses on the complex interconnection, interdependence, and intercommunication between users and information professionals and consists of three sections. The first is a profile of users of agricultural information—who they are, some features they share, and problems they face. The second reviews trends in agriculture and information delivery. The concluding section examines implications of these characteristics and trends and suggests some recommendations based on them.

In spite of the evident importance of users, systematic concern with and interest in them is a comparatively recent development in agricultural librarianship. A review of the last thirty years of the *Quarterly Bulletin of the International Association of Agricultural Librarians and Documentalists* (IAALD) and of the World Congresses of the IAALD reveals a gradual shift of focus, beginning in the 1970s, from papers about collections, documentation activities, networks, secondary services, and automation to papers which address or examine the library user. At the fifth World Congress, Laux (1978) presented a paper on user requirements noting that, despite thousands of years of library history, very little attention has been paid to the user. While users have been statistics, only recently have individual users and their requirements been the focus of any inquiry (p. 27). This growing interest in the user is exemplified by the theme of the eighth IAALD World Congress to be held in Budapest in May 1990—"The User as the Aim of Information." In 1982, a "blue-ribbon panel" assigned to assess the National Agricultural Library (NAL) for the U.S. Secretary of Agriculture focused its examination on user needs. This approach would probably not have been the one taken for such an inquiry ten years earlier. In the words of the panel, "only through the eyes of its users could a true picture be derived of what NAL should and could be" (Interagency Panel on the NAL, 1982, p. 2). All of the panel's budgetary recommendations followed from user requirements and, in addition to specific proposals for services, the panel called for NAL to develop mechanisms for an ongoing survey of user needs (p. A-1).

Interest in users and their satisfaction seemed to coincide with the advent of online systems, although descriptions of user needs can be found occasionally in earlier reports about agricultural library services (e.g., Brookland & Watson, 1957). Reports or studies of user assessment of precision and recall of automated bibliographic retrieval systems, as well as surveys analyzing the reasons users requested searches, began to appear in the 1970s (e.g., Martin, 1977). Not only was there a large investment in these systems, but information-seeking behavior became easier to observe and satisfaction easier to measure through the online search request. When the National Agricultural Library instituted the Current Awareness Literature Service (CALS) for the U.S. Department of Agriculture's Agricultural Research Service (ARS), periodic user studies were conducted to determine ways to make the service more responsive (Burton, 1976). Online bibliographic retrieval systems not only offered some relief from the tedium of literature searching, but they provided the opportunity for a new librarian-user relationship. Oyler (1975) observed that online retrieval is seen by users to "mark the library's advance to being a purveyor of information and shedding some of its curatorial image" (p. 2). It is in the library's role of supplier of information that the market or the client takes on increased importance.

Distinctive Features of Agriculture

Before examining what is known about users, it may be useful to review characteristics of agriculture that have particular implications, not always shared by other disciplines, for users and library services.

Unlike physical and chemical technologies, the practice of agriculture is highly dependent on location. Users are therefore extremely sensitive to their geographic differences. Issues of climate, soil, economics, and national policy are critical to specific applications of information. This is surely one of the most distinctive features of agricultural information.

Governments of all nations have a vital interest in sponsorship of agricultural research and dissemination of information. This has generally meant that most information is "open"—there are few trade secrets such as those which exist in other industries—and that governments play a pivotal role in information transfer, often through networks of agricultural extension agents.

Although information is open and available, its provision is complicated by at least three distinctive factors. First, agriculture is interdisciplinary at a number of levels—scientific, social, and economic. Agriculture encompasses the life sciences. In fact, Garfield (1978) found that agricultural scientists use and cite the same core of journals cited by all researchers in the life sciences, and believes that agriculture describes only the mission rather than the approach to a problem (p. 138). At the same time, agriculture is much broader than the life sciences, intersecting social sciences, physical sciences, and engineering.

Second, agriculturists are dependent on tremendous amounts of nonbibliographic, nonresearch data, some of it of a very timely nature such as price and weather information. Taxonomic, chemical, epidemiological, clinical, and genetic information constitute vast data files. These increasingly important and widespread factual databanks are discussed in various reviews (*Factual Databanks,* 1978; Porta, 1986).

Finally, unlike medicine, for example, where the practitioners may be fairly conversant with the language of research, there are special requirements for the treatment and presentation of information to diverse groups of agriculturists. Agriculture in most countries is dependent on a structure of translators of technical information—i.e., agricultural extension agents. Information must even be packaged for illiterate practitioners. Lancaster and Beecher (1981) suggest that there is growing recognition of the needs of the nonscientific user of information—recognition of the fact that information must flow from research to extension services in a form suitable for practical application under local conditions (p. 199).

A Taxonomy of Users

What is really known about users of agricultural information? While conventional wisdom abounds and will be reviewed here later to some extent, there is a relative dearth of real knowledge about the users of agricultural information. This gap is evidenced in both industrialized and developing countries. While librarians are now exhorted, although not necessarily taught how, to examine user requirements, Broadbent (1977) submitted that no one is very sure what the user wants. According to Russell (1984), a scarcity of documented evidence on actual information needs of agricultural users continues into this decade in spite of a long history of government involvement in agriculture (p. 55). This discrepancy is particularly true in the United States, although both the library sector and the extension sector have produced some recent studies of agriculturists (e.g., Olsen et al., 1985; Richardson & Mustian, 1988a, 1988b). Undoubtedly the study of users is made more complicated by the vast scope of agriculture. In the United States, for example, it is the biggest industry with over 20 million people engaged in some phase of it (Frank, 1987, p. 293).

In order to make some inroads in developing a profile of information-seeking habits, sources, and needs of agriculturists, and barriers to their satisfaction, it is helpful to identify distinct groups of users. Although the usefulness of distinguishing between different groups of users is generally recognized, researchers do so in different ways. For example, Deirg (1973) lists only three categories—research/technical, advisory/extension, and research administration/planning (p. 66), while Russell (1983, 1984) distinguishes among policy makers and administrators, research scientists, diagnostic and analytical scientists, specialist advisers, general advisers, educators and students, agricultural service industries, and farmers and rural people (Russell, 1983, p. 43). Metcalfe (1981) proposed eleven categories arranged into two groups: those who use the primary literature (research scientists, industry, specialist advisers, educators, and students) and those who do not (planners, administrators, banking and commerce personnel, journalists, general advisers, highly educated growers, and other growers). He charts exactly which of more than a dozen different kinds of literature and other information delivery mechanisms are used by members of each of these categories (p. 117).

A classification which is a compromise among these approaches is adopted in this article. In terms of documented evidence regarding user groups, users can be conveniently classed as follows with some variations and overlaps: (1) scientists and researchers; (2) extension scientists or researchers; (3) extension advisers; (4) farmers/producers; and (5) others—policy makers/administrators, workers in agribusiness, educators, journalists, and even consumers.

Scientists

Scientists comprise the most studied group of information users and findings that apply to scientists in general—especially to life scientists—can be extended to agricultural scientists. Information needs of scientists are generally considered to be met through the well-established scientific journal system and secondary bibliographic services. Yet scientists' initial source of information is generally people—specifically their colleagues. Scientists communicate with their colleagues via telephone, electronic mail, correspondence, conferences, and so forth. They exchange preprints and proposals. Busch and Lacy (1983) observe that, although formal scientific communication is highly visible and the informal network difficult to observe, both are equally important (p. 86). The network of informal scientific communication is called the "invisible college," and it has been well documented (e.g., Crane, 1972) and can be traced back for centuries (Price, 1986). Others (Allen, et al., 1971; Cooney & Allen, 1974) expanded on the premise that the scientist's first and most important source of information is other scientists, by identifying what they call the "internal consultant" or "technological gatekeeper" who can be found in any scientific firm or organization (Allen et al., 1971, p. 38). In the Cooney & Allen study of An Foras Taluntais (Irish Agricultural Institute), a network which extends throughout Ireland, they found that certain individuals served as intermediaries between typical members of the group and external sources of information. These individuals showed "significantly greater use of the professional and scientific journals" and maintained "ongoing informal contact with colleagues in other organizations, particularly in universities and nonprofit laboratories" (p. 38).

In another work, Lancaster and Smith (1979) review scientific communication and major findings from user studies. Again, informal channels—the invisible college and private files of notes, preprints, offprints, etc.—are documented as important sources for scientists (p. 380). They report that scientists value convenience, improved selectivity in information services, and more rapid access to research results. The significance of the invisible college and the utility of private files suggests that minimizing effort is a major factor in scientists' information behavior.

Turning specifically to agricultural scientists, Olsen et al. (1985)

examined information habits at a major U.S. land-grant university. Their survey was motivated by the conviction that library service should add significantly to the research process and by the assumption that faculty are underserved in academic libraries. The study of Cornell University agricultural scientists confirmed that both personal contact and individuals' own private files were significant in their keeping informed of current research and literature (p. 13). Library services of greatest importance (i.e., more than 50 percent of the 327 respondents stated "essential" or "very important") to these users were materials loan, telephone reference, immediate photocopy service, self-service photocopying, reference librarians, and computer literature searches in that order (p. 14). Much lower ranked, but still very important to a sizable minority, were delivery of library materials to individual offices and availability of personal computers in the library.

Voss and Wiedeman (1981) provide a study of the information habits of grassland scientists in which respondents (n = 272) ranked importance of information sources. Not surprisingly, scientific journals ranked at the top, followed distantly in descending order by books, meetings, colleagues, abstract journals, literature retrievals, card services with abstracts, bibliographies, and information from libraries (p. 279).

Trueswell (1969) has discovered that demand for scientific journals parallels typical demand for inventories in business. He found that roughly 80 percent of user demands are satisfied by 20 percent of the collection in a variety of scientific and other libraries. Trueswell's rule was confirmed and exceeded in a recent study of Danish veterinarians and agriculturists (Hansen, 1981) in which 85 percent of the requests (n = 2,839) were for 7 percent of the serials (p. 89).

More than forty years ago, Gilman (1947) stated that the greatest needs of scientists were to be liberated from the increasing drudgery of literature searching, to be kept abreast of current information, and to be assisted by any tools which will help relate vast amounts of data and information (p. 331). While computers may have relieved some of the drudgery, the needs of scientists are still the same and have been intensified by the growth in the literature. The amount of time scientists spend seeking information is therefore worth examining in some detail, if only because a goal of information services should be to minimize that time. As Chen (1974) has pointed out, a library is effective only if it "can maximize satisfaction of user needs and minimize time loss to the user" (p. 272). The study at Cornell University (Olsen et al., 1985) found that 35 percent of the faculty spent 10 percent and 32 percent spent 5 percent of their research time in the library. Most also used graduate students and research assistants to perform library-related activities (p. 12). Deang (1977) reports that researchers in experiment stations spend 20 percent of their time seeking information and asserts that their biggest problem in making research proposals is the review of literature.

While journal literature may be reasonably accessible, scientists perceive and report at least two major barriers to information use—document delivery and the intractability of machine-readable data. The first of these is even a problem in industrialized nations as Voss and Wiedeman (1981) reported in the earlier-cited study of grassland scientists in West Germany, Austria, and Switzerland. Only 58 percent of the 272 respondents were able to obtain more than 50 percent of the journal articles recommended by literature searches. This barrier to obtaining documents helps explain why 95 percent also declared that abstracts are a "substantial advantage" in bibliographic products (p. 283). Speed in receiving publications or full-text, regardless of higher price, also has been verified by Olsen (1982) to be of great value to agricultural researchers and scientists.

A second important concern is lack of success in obtaining machine-readable information. Although not specific to agriculturists, a recent U.S. National Academy of Sciences report ("Information Technology," 1989) notes major barriers (e.g., idiosyncratic methods of organizing and retrieving data) encountered by scientists in their attempts to access electronic information (p. 27). The most fundamental impediment to use of existing information technology is the absence of an underlying infrastructure:

> Just as use of a large collection of books is made possible by a building and shelves,...a cataloguing system,...and reference librarians to assist users, so the use of a collection of computers and computer networks is supported by the existence of institutions, services, policies and experts—in short by an infrastructure. (p. 43)

This infrastructure has not yet been established in a systematic and comprehensive manner. Those not expert in the use of computer and telecommunication systems are therefore presently disadvantaged—vital but little-used data may well be lost in the system, and it is difficult for users with urgent needs to obtain timely assistance. These problems, among others, would be resolved with the development of the requisite infrastructure, a task that will require the joint effort of government agencies, universities, and libraries.

Extension Advisers

Extension specialists can be divided into two groups—researchers who use the scientific literature and advisers who assist farmers with practical problems. The first group is similar to scientists in information needs and use of the primary literature and will not be discussed in any detail here. The second group, whose job it is to transmit information so that it makes a difference to agricultural practitioners, is of particular interest. The extension adviser is found in many countries and embodies a mandate to disseminate information. As such, extension performs a kind of "translating" service from scientist to practitioner—it "collects, digests, combines, analyzes, [and] passes on results of scientific research in a completely new form" (Koster, 1971). In summarizing the sixth IAALD Congress, Buntrock (1981) concludes that the information needs of extension advisers are not well met by the global, formalized information systems, and that more attention must be given to nonscientific users—that is, to extension advisers and farmers (pp. 335-36). Extension advisers are not concerned with the theoretical but with what is applicable to local conditions. Because of the difficulty in selecting these specific applications from a large international literature, Maltha (1972) considers service to extension one of the most difficult problems facing documentalists and information officers (p. 175). Extension advisers need to keep up with new developments and respond to inquiries. Like scientists, they have too much paper and not enough time; unlike scientists, they are generally far from any libraries.

Bernardo (1981) classifies extension workers into three categories: field technicians, subject specialists, and administrators. Field technicians need "packaged technology in simple language"; subject specialists—who undertake verification tests, conduct training, and develop packaged information—read scientific journals and technical bulletins; extension administrators use both scientific and management literature (p. 14). Peart (1978) provides an extensive review of the information needs and habits of advisers, noting the great breadth of subject matter on which they must be prepared to advise, the genuine urgency with which that advice is requested, and the need for information not only to be directly applicable to commercial farming, but also to be relevant to "local, often transient, circumstances of climate and economics" (p. 74). Peart reported that the main sources of information for the advisers employed by the Official Advisory Service in England and Wales were:

1. personal collection and private files which might contain extension leaflets, results of experiments, and private communications;
2. personal consultation with regional specialists; and
3. the invisible college—farmers, other advisers, university scientists; leading local farmers figured especially prominently in this network (p. 81).

Another study of advisers in Scotland and Northern England (Agar et al., 1984) confirmed that respondents relied heavily on personal contacts with other advisers, specialists, and farmers, because this was a convenient way to obtain information (p. 226). This study also revealed a large number of topics for which concise information is needed. The response to this need was to launch several bulletins and to develop a specifically tailored database of agricultural extension and development literature (p. 227). A European Community symposium (*Information Management...*, 1977) also concluded that extension needs are not met by existing information systems. Specifically, it cited the need for up-to-date scientific/technical information, familiarity with current work at research centers, market and price information, and information on new agricultural products (p. 9).

A related case is provided by the needs of the agricultural industry which can be defined as commercial enterprises which process agricultural produce or which sell products to agriculture. Maltha (1971) suggests that their information needs fall somewhere between those of scientists and advisers, with larger firms more interested in science (p. 274). A critical factor in the demand for information is the number of technicians in a particular industry—the more technicians, the greater the demand for information.

Farmers

Farmers and producers are the ultimate end users of agricultural information. Because farming is a technical activity, its practitioners face some of the same problems as scientists and advisers—agriculture's information base grows while problems facing farmers are ever more complex. A number of studies have explored the kinds of information farmers need and their preferred means of obtaining it. Although a videotext experiment with market, weather, and technical information was not a success, Case and Rogers (1987) found that farming in the United States has become an information intensive occupation with much time devoted to seeking information from farm magazines, extension, the media, and other farmers (p. 61). Chartrand, Carr, and Miller (1983) cite a National Opinion Research Center survey in which U.S. farmers were asked if they were dissatisfied with current sources of information. According to Chartrand, they reported lack of confidence in the accuracy and reliability of information and complained that available information did not apply to their locales, was too general or vague, too outdated, or too costly or difficult to obtain (p. 11). Warmann (1988) surveyed farmers in Virginia and found that although they were unsure about what type of information would be of greatest value to them, they viewed the extension service as a valuable source of information, and indeed as their most important source of production information. Studies by the North Carolina Agricultural Extension Service also confirmed the value of extension in delivering information and found farmers expecting to need more complex technical information in the future (Richardson & Mustian, 1988b), but not expecting to change their preference for traditional delivery methods (Richardson & Mustian, 1988a). Palmer (1986) reports that farmers in the United Kingdom rely on friends, the national farming press, the media, government and commercial advisers, and "very direct access to research" (p. 102).

The role of information in the adoption of new technologies or agricultural innovations also has been the subject of some investigation. Similar conclusions were reached in a number of case studies of agricultural innovations conducted by Consumer Dynamics for the U.S. Department of Agriculture (USDA) (Consumer Dynamics, 1980). Most farmers interviewed were found to be "serious, active, and relatively sophisticated users of technical information." Their central sources of information were printed materials and interpersonal communication (p. 18). They did not rely heavily on mass media. It is also interesting to note that, although the printed information promoted awareness and understanding of new techniques and innovations, it was not usually the dominant factor in the decision to innovate (p. 18). Instead, a single strong intermediary, such as a local extension agent, was the important factor in those decisions. Additional personal contacts served to reinforce decisions. Duces and Strawhorn's (1981) case studies of the adoption of innovation also identified personal interaction as central in obtaining information. Another case study of innovation, conducted to assess the impact of the USDA's 100 years of information dissemination, found consonance with the individual's values, continuity with past practice, and testability on a small scale to be important factors in decisions (Sophar & Murphy, 1981).

Users in Developing Countries

Agriculturists—scientists, extension agents, and farmers—in developing countries have unique problems and at the same time share characteristics—albeit sometimes on a different scale—with their counterparts in industrialized countries. Because of their relatively smaller numbers, scientists in developing countries may not enjoy the benefits of invisible college communication which has been shown to be more active in the United States than in other countries, probably because of the number of American scientists (Busch & Lacy, 1983, p. 87). However, rapid growth in the number of scientists in developing countries should mitigate this disadvantage (Lancaster & Smith, 1979). At the producer level, Williams and Williams (1984) found that Nigerian farmers ($n =$ 140) relied foremost on friends and village elders for information and very little on government agencies. While this result confirms the general propensity to consult colleagues first, it also may reflect both a scarcity of agricultural advisers and the illiteracy of the respondents.

Because of the importance of extension agents in digesting and applying information to local conditions, the inadequacy of existing extension programs is probably the major barrier to information transfer in developing countries. In addition, whereas scientists and researchers worldwide enjoy the benefits of a lingua franca, namely English, end users in developing countries often have no such advantage, and translating information into local languages for advisers and producers presents another barrier to its successful dissemination and application. This highlights the need for selective translation and dissemination services and, in fact, documentation efforts in many countries concentrate on translating from several languages into the vernacular. Illiteracy of farmers has been successfully confronted by using nonprint forms of information transfer—the mass media, training centers (Reddy, 1987), and portable audio and video (Storm, 1982). It is undoubtedly dangerous to make generalizations about users in developing countries. In fact, differences within a country may be as extreme as differences between countries; in some countries, for example, a large difference between information resources available to urban and to rural users has been observed (Gregorio & Sison, 1989).

As noted earlier, there is a relative paucity of data on U.S. users of agricultural information. By contrast, and in consideration of the numbers of librarians and documentalists, the literature reveals a substantial effort to obtain user feedback in developing countries (as well as in other industrialized ones) and to understand information needs. In a study of Nigerian veterinarians, for example, Ikpaahindi (1985) found that only 18.7 percent of the respondents ($n = 64$) were nearly always successful in satisfying their most important information needs (p. 149). Not surprisingly, delay in receipt of needed publications was a significant hindrance to these veterinary scientists and practitioners. User involvement in the design of information services in developing countries is especially important given the tremendous investments which must be made in core resources and infrastructure. This was recognized by U.S. Agency for International Development (USAID) officers, who, from the beginning, saw user feedback as critical to a project designed to extend the National Agricultural Library's Current Awareness Literature Service to developing countries (Dewey, 1981).

Common Elements

The foregoing review of distinct user groups discloses common elements as well as significant differences. A striking common denominator among these user groups is the importance of people in information delivery. This is true for the scientist who relies on colleagues in the invisible college, for the agricultural adviser who depends on a host of others, and for the farmer who relies on the extension adviser as well as other farmers. Personal contact seems no less important in industrialized countries than it does in developing countries. Rarely are librarians important people in this information chain. Indeed many of the users discussed do not use libraries at all. However, it is reasonable to say that all users expect libraries or information services to deliver needed information when required. They all need to be kept informed and to research a particular topic on occasion.

The hierarchy of information sources used most often by all groups emphasizes the importance of convenience in obtaining all types of information, be it for keeping current or for researching specific topics. In a rare presentation to librarians by a user, Dagnelie (1978) confirmed this propensity by suggesting that users will ignore a system if it becomes too complex, cumbersome, or expensive.

A number of common obstacles to obtaining needed information are also suggested by the foregoing survey.

—Document delivery capabilities do not equal bibliographic capabilities. Although not perfect, bibliographic capabilities are well developed in agriculture. Brennen (1975) even asserts that probably no branch of science is more accessible than agriculture—e.g., the Netherlands Center for Agricultural Publishing and Documentation (PUDOC) publications are indexed in forty-three secondary services (p. 88). And yet users—at all levels and in both industrialized and developing countries—repeatedly report difficulties in obtaining their publications when needed. The knowledge that so much literature and information exists may even increase user frustrations. Of the 130,000 references added to AGRIS each year, 16 percent are considered "grey literature"—nonconventional materials which are difficult to obtain (Samaha, 1984). There has been far more emphasis in the profession on examining bibliographic retrieval systems than on either user satisfaction with those systems and or with the goal of bibliographic processes—namely, obtaining useful information. Even in the United States, one of the major recommendations from the USDA Agricultural Research Service (ARS)/National Agricultural Library review of library operations (National Agricultural Library Project Review Team, 1988) was that document delivery needed to be more timely and to achieve a better fill rate (i.e., provide a higher percentage of documents requested). Representative Robert G. Toricelli (1984), in speaking to the U.S. Congress in support of a bill to promote dissemination of biomedical information (the category of information often considered to be the most accessible), noted that scientists' needs are for immediate document delivery. Instead, "the search [for documents] is so frustrating and time-consuming that it is sometimes referred to as the 'paper chase'."

—Documentation and document delivery services are slow. Concern for speedier services receives prominent attention by users in many user studies and in all countries. Apart from the utility of timely information, Laux (1973) asserts that speed is a worthy end in itself, because it raises confidence in the information partnership, thus casting the librarian in the role of an active, effective, and involved colleague.

—The complexity and quantity of information coupled with user inability to exploit available resources constitute yet another barrier. Broadbent (1977) considered user ignorance and "basic inability to make use of existing information tools and services" to be the largest problem confronting efficiency in information systems (p. 15).

Documentation and Online Services

Documentation, or preparation of current awareness and abstracting and indexing tools, is central to librarianship and has in fact dominated much of agricultural librarianship. Automation of these services has especially demanded energy and attention in recent decades. Because of the tremendous intellectual and fiscal resources devoted to secondary bibliographic services, it is important to examine specific efforts to gain user feedback with regard to them. There are several indications of the critical significance of abstracts to users (von Frauendorfer, 1959; Deang, 1977; Müller & Friis, 1980,), although their creation obviously reduces speed of publication, which is a competing user preference. Von Frauendorfer (1959) also found quasi-unanimity in accepting English as the language for an international abstracting journal. While these studies seem to confirm the value of such services to users, it is also useful, in examining the effectiveness of bibliographic services, to keep in mind their relative contribution as a source of information for many scientists and researchers. Hálaszi's survey (1970) of 664 visitors (mainly scientists and students) to university and institute libraries in Wageningen, Netherlands, found only 40 percent of the clientele interested in abstract journals (p. 19). Information tailor-made to local circumstances was more attractive. In Van Styvendaele's (1977) study of scientists at Antwerp State University Centre, users (3,458 replies) reported citations in articles as their main source of references to the periodical literature (54 percent), followed by current awareness tools such as *Current Contents* (21 percent), and conventional abstract journals (15 percent). The remaining 9 percent were from computerized literature searches (which might be considered a machine equivalent of abstract journals), browsing, and theses (p. 271). Their main source of references to books was publisher announcements (Van Styvendaele, 1981).

Studies of users of online services are plentiful but tend to focus on precision, recall, and purpose of request rather than on structure and content of particular databases. The Interagency Panel (1982) that reviewed the National Agricultural Library critiqued the quality, timeliness, and ease of use of AGRICOLA—all of which needed improvement from the user's viewpoint. In Cornell's study (Olsen et al., 1985), users ranked online services and abstracts and indexes ninth and tenth respectively as means to keep current in their fields. Heading the list were: reading journals in their own and related fields; using their own collections; references in articles, conferences, correspondence within and outside of their university, and consulting experts (p. 13). Preferences by users for hard copy over online also is occasionally reported (Maciuszko, 1989; "British Library Report," 1988). As users increasingly search databases themselves, these end users have become the subject of investigation at least in the medical field ("Survey of Individual," 1989; Marshall, 1989).

Trends in Agriculture

It is also useful to identify trends in agricultural research and practice which might affect users and which have implications for their information service needs.

In some industrialized countries there is a decrease in the number of farmers/producers and a growing sophistication of those remaining in the business. Jones (1978) maintains that the decline in the number of people engaged in agriculture implies a willingness by those remaining to make a greater intellectual investment in farming (p. 108). Coupled with the increasing scale of farms, Jones suggests that the information needs of farmers may converge with those of workers in agribusiness and advisers. Remaining farmers must maximize economy, and information is important to doing so. In the United Kingdom, Read (1987) found that, with a rise in the general level of education, farmers tended even to bypass advisers and go directly to specialists (p. 35).

Both the United States and the United Kingdom have experienced decreasing government support for agricultural research and information activities in recent years. The increasing reliance on the private sector, as documented by Palmer (1986), Read (1987), and Kranich (1989), has implications for information and users. Palmer (1986) suggests that the decline in free government advice leaves the user confronted with a bewildering profusion of packaged advice, none of which will be free (p. 108). Already the end user who can afford to purchase information is increasingly catered to by the commercial information sector. In spite of the potential of technology to overcome rural isolation, it may actually exacerbate information inequality because of the cost of these commercial services.

There is growing public interest in agriculture and its role in creating and solving environmental problems as well as in assuring the safety of the food supply. The scope of agricultural information is expanding accordingly. A workshop sponsored by the Rockefeller Foundation (*Science for Agriculture,* 1982) focused on the need to strengthen agricultural research in order to meet "complex challenges facing American agriculture" (p. 5). Its participants called for greater institutional collaboration and interdisciplinary efforts. If the workshop's recommendations come to fruition, users of agricultural information should become even more diverse while the information needs of agriculturists will broaden in scope through the sciences and technology. Because everyone is a consumer of agricultural products, the growing interest of the public in the safety and nutritional value of food may translate into increasing numbers of consumers seeking technical agricultural information.

The staggering rate of the world population increase and the concomitant needs for food suggest the urgency of increasing the number of extension workers in developing countries. Packaging information for local circumstances is likely to increase in importance.

Trends in education affect faculty and students and therefore library services. Studies such as one conducted by the Pew National Veterinary Education Program suggest that learning how to exploit information resources in fast-changing fields is becoming essential to education (Pritchard, 1989). Although curricular changes are typically slowly implemented, this recognition by educators suggests a more vital educational role for the librarian.

Trends in Delivery of Information

While the rapid growth in scientific and technical literature is hardly a new concern, the rate of growth continues to accelerate. Other forms of communication have emerged, but the journal article, for all its problems as a vehicle of communication, is not going to disappear in the near future. Indeed, the number of scientific journals and the size of existing journals have grown exponentially. This so-called explosion is perhaps most dramatically quantified in the field of chemistry. *Chemical Abstracts* now produces about a half million abstracts per year. Users at all levels find it increasingly difficult to read and digest all the relevant information. Besides the sheer quantity of information with which users must cope, other results of this proliferation include slowness of publication and increasing specialization which makes it more difficult for scientists and technicians to communicate with each other. Compounding the problem of information surfeit may be a relative decline in syntheses of the literature. Deirg (1973) asserts that the growth in scientific literature has been accompanied by a decline in the production of review articles, a phenomenon he attributes to lack of reward to scientists for this type of effort. Whether or not Deirg is correct, assisting users with this sea of unsynthesized information becomes ever more important.

The cost of scientific literature, which is only partly a function of the growth in the literature, has escalated rapidly in the 1980s. While much agricultural research is government sponsored and available in government publications, agriculture depends on the basic sciences. Inevitably, a smaller proportion of the primary literature will be at hand even at well supported U.S. land-grant universities. This trend implies not only a need for increased attention to speedy document delivery, but a greater need for partnership with users in order to shape collections for optimal satisfaction.

Recent years have witnessed another more subtle change for many users of agricultural information—the consolidation of departmental libraries. Budget and space constraints as well as the increasingly interdisciplinary nature of science and agriculture have contributed to this unification. This consolidation has occurred in the U.S. National Agricultural Library and in many land-grant institutions, where agricultural libraries have merged with other branch libraries to become science libraries. Olsen (1979) laments that with this trend has come an "inexorable reduction of services and use by researchers, advanced students and field practitioners" (p. 113). Less personal and less frequent contact with users may exacerbate barriers between librarian and agriculturist.

TECHNOLOGY

Technology has created new forms of information transfer and manipulation. While bibliographic databases have surely assisted the user in identifying material on a specific topic, Deirg (1973) asserts that the "computer has aggravated matters by its very thoroughness" in providing ever more information, not all of it relevant (p. 66). In its many forms, information technology has been recognized as important to agriculture and has become the focus of government attention. For a review of information technology in the United States, see *Information Technology for Agricultural America* (1983). Considered later are several examples of recent developments in information technology—databanks, telecommunications, CD-ROMs, and personal computing.

The National Agricultural Library study (Interagency Panel on the NAL, 1982) revealed a nearly universal interest in a national system of agricultural databases and databanks all accessible via a telecommunications network (p. 2). In the users' vision, stage one should provide online availability of statistical series and complete texts of selected documents; stage two should be online availability of the latest confirmed findings:

> User queries to this system would yield specific answers adjudged to be the latest, most scientifically correct by professionals assisted by peer panels who would keep abreast of the literature in their areas of expertise and update the database accordingly. (Interagency Panel on the NAL, 1982, p. O-5)

Perhaps in response to the panel's recommendations, NAL has launched some full-text experiments, notably NAL's Text Digitizing Project and its *Pork Industry Handbook.* The impact on and response by users of these prototypes has not yet been assessed. At the same time, there are many databanks of factual information in agriculture, particularly for dated information—e.g., market and price reports—but they are not easily available through a single network. The library profession has a vital role in designing, on a national and international basis, the systems and infrastructure to realize the vision of these users.

That infrastructure is very much dependent on telecommunications networks which are already facilitating electronic publishing in agriculture. In the 1988 report to the U.S. Secretary of Agriculture, the Joint Council on Food and Agricultural Sciences described an electronic publishing venture designed to mitigate the fact that USDA Agricultural Research Service research results were not reaching state extension specialists until many months after research was completed (Joint Council, 1988). By mounting new, unpublished ARS research results on the Cooperative Systems Information Network (a computer-/telecommunications link consisting of the ARS TEKTRAN computer database and Extension Cooperative Systems Information Network's telecommunications capabilities), extension agents at land-grant universities and, in many states, county agents, could access immediately 100 to 125 new reports each month thus increasing availability and timeliness of information. A less pronounced, but very significant, side benefit was that the field test increased the direct contact between ARS researchers and Cooperative Extension Service specialists (p. 22). Contacts between individuals may be further facilitated by modern telecommunications capabilities which enable electronic mail and bulletin board use. To that end, the National Agricultural Library has recently launched Agricultural Library Forum (ALF), an electronic bulletin board with potential for linking people, instant delivery of search results, and receipt of document delivery requests.

Regardless of costs, the online revolution has not had an impact where telecommunications infrastructures are weak. Not dependent on telecommunications, CD-ROMs may allow that revolution to reach the developing world. Kinney (1988) reports a positive experience with AGRICOLA on CD-ROM in Malawi in spite of document delivery barriers. The potential of CD-ROM for such locales was also recognized by a recently funded project at Cornell University to identify the core literature of agriculture and convert it to optical disc ("Project at Cornell," 1989) and in BLDSC's (British Library Document Supply Center) trial of document delivery through CD-ROM ("BLDSC Tests Delivery," 1989). At the same time, some expect that the various logistical difficulties associated with CD-ROMs will serve to refocus attention on online capabilities (e.g., Martin, 1989).

Farmers and extension agents increasingly are using personal computers for data manipulation and for direct access to databanks although there is some disagreement as to the extent of that use. Chartrand et al. (1983) observe that farmers and extension agents were among the first to use computers in the 1960s for record-keeping and farm management (p.11), and Read (1987) found increasing reliance on microcomputers by private consultants and public agricultural advisers in the United Kingdom. However, Case and Rogers (1987) asserted that only 6 percent of U.S. farmers have computers and that development of appropriate software lags behind other business sectors (p. 63). Microcomputer technology positions farmers and others to be direct users of information services, and there has been an accompanying rise in commercial services and at-home access. It even has been recommended that the U.S. National Agricultural Library could relate more directly to users (National Agricultural Library Project Review Team, 1988).

Implications for the Information Professional

What do these user characteristics and trends suggest for the role of the information professional and for information services? Unequivocally, they call for closer relationships between information professionals and users and among the users themselves. An analysis of the mechanisms for information transfer and application among agricultural users suggests several ways in which librarians and documentalists can be more effective.

Because of the centrality of personal contacts in information transfer, an important role of information professionals is surely in designing systems and services that can facilitate and enhance the relationships of scientists with each other. This is not a new idea but one that fully warrants repetition and reinforcement. Even in 1957, Brookland listed telephone calls to government offices, learned societies, manufacturers' associations, newspapers, the Commonwealth

Bureaux, university departments, foreign embassies, and other firms as important resources for an agricultural firm's information service (p. 100).

There are numerous examples in agriculture of databanks and specialized information services for which people contacts are considered key components. The Pacific Coast Forest Research Information Network (PACFORNET, now FS Info—Forest Service Information) regards "linking users to subject specialists" as a vital part of reference service (Yerke, 1976). The Aquatic Sciences and Fisheries Information System (ASFIS) has a register of experts—700 individuals whose expertise may be valuable to aquaculture—and institutions (Caponio, 1977; Dopkowski, 1981). The Postharvest Institute for Perishables Information Center (established at the University of Idaho with support from the U.S. Agency for International Development), whose primary goal is to reduce crop losses in developing nations, maintains an extensive online listing of experts (George, 1981). A number of electronic systems have shown that using personal contacts is an important benefit. Both the ARS electronic publishing experiment and the development of the Nebraska databank AGNET (AGricultural Computing NETwork, a network which contains 200 computer programs and gateways to other information sources) resulted in facilitating contacts between people.

Contacts between users can be enhanced in more informal ways as well. A strong relationship between a librarian and an organization's "gatekeepers" may in fact disseminate information farther than several library-patron contacts. As Cooney and Allen (1976) exhort, information specialists should play a role in supporting the gatekeepers, in bringing other scientists into contact with them, and in facilitating information transfer between them (p. 111). Librarians can and should play a valuable part in enhancing relationships between formal and informal information channels.

The bewildering profusion of both scientific-technical literature and technology suggests a second, increasingly important role for librarians and information services. This role is played out in a variety of ways—i.e., by sifting the literature, managing electronic technologies, and instructing users in doing the same. Sifting the literature is a traditional activity, but its importance is progressively magnified by the growth of science. As Jennings (1957) noted in describing the New York State Agricultural Experiment Station Library, the culling of literature as it arrives for material pertinent to researchers was one of her most important tasks. Today there are many tools to assist with that task, but it has been nearly abandoned in many libraries with large and diverse clienteles. Subject knowledge on the part of information professionals may be increasingly important because in some settings such culling may involve selecting material applicable only to local soil, climate, and economic conditions.

There is a need to index and control not only literature, but also software, databanks, and even people contacts. Librarians have focused tremendous energy on library technologies but much less on user-oriented technologies. A librarian or information professional must have expertise in the management of information systems and be as conversant with a whole panoply of hardware, software, and databanks as with books and journals. A librarian must be familiar with large numbers of databanks and specialized information services and be able to advise users in accessing them. These have clearly come to play a central role in agricultural information and, for the most part, they have been developed outside the library milieu to handle vast amounts of factual data—for example, data regarding pesticides (NPIRS—National Pesticide Information Retrieval System) and germplasms (GRIN—Germplasm Resources Information Network) (see *Factual Databanks,* 1978; Porta, 1986). Decentralization of information delivery directly to users does not mean that the librarian's role is diminished. Instead, librarians need to facilitate end user access by advising on the array of commercial services available to users as well as on hardware and software. They need to take on "information counseling" roles as championed by Horton (1982). Frank (1987) even suggests a new professional—a "farm computer consultant"—with skills in finance, marketing, and management (p. 310).

Finally, the information professional's role in response to the explosive growth of scientific-technical literature and technology includes providing end user instruction and assisting users directly to access the assemblage of databanks and services and this role will surely increase in importance. The complexity of the information world requires a trained user and there is a need for users to exploit better existing resources. Especially in circumstances with limited information personnel, the user should not have to be dependent on the librarian. At the same time it is essential to remember that time is a valuable commodity. The goal of user education programs should be to decrease, not increase, the time a user has to spend gathering information.

Another major goal for all information professionals and organizations worldwide is providing fast document delivery by utilizing modern telecommunications capabilities. Like any other tool, information is not useful if it is not available when it is needed.

Information professionals also must develop services that help meet both very general and highly specialized information needs. Buntrock (1980) predicted that the European Community would emphasize promotion of so-called "value added" information systems—systems which combine information analysis and factual databanks to answer all kinds of online and offline queries from all kinds of users. Indeed, the success of all-encompassing information services regarding particular commodities or activities suggests the need for this kind of vertically integrated information service in a more general setting. An excellent example is the databank AGNET. Created with regular user feedback, it grew as a result of user needs with no type of information considered out of its scope. FS Info, referred to earlier, was the result of an effort to change the way of thinking about information services. Its "beauty is that it creates a web by linking librarians, information centers, researchers, practitioners, and editors within the U.S. Forest Service" (Rutherford, 1987, p. 1). There are many other examples of vertical integration, or comprehensive information services, including the USDA Information Center for Animal Disease Emergencies in Hyattsville, Maryland (Pilchard, 1978); a USAID sponsored workshop for development of an international sorghum information network (Olsen, 1975); and the clearinghouse at BIOTROP—Regional Centre for Tropical Biology located in Bogor, West Java, Indonesia, which combines scientific information, publications, and public relations functions (Sahertian-Bakhoven & Soedojo, 1983).

The importance of convenience and the growing universe of information suggest that more personalized, specialized information services are also needed. Drake (1982) provides a particularly helpful description of such a special librarianship model. It calls for information management which combines a gathering function with analysis, synthesis, and delivery in a usable form (p. 227). It also requires a marketing approach that begins with customer needs, wants, and expectations (Drake, 1982, p. 231). This marketing approach, which has been the hallmark of special librarianship, focuses on developing appropriate services and products for each segment of the clientele and continually assessing satisfaction of both users and potential users. Not only is each segment important, but it is increasingly possible to tailor services to individual needs and modi operandi. Another illustration is provided by Lancaster and Smith (1979) who define the special library model as: (1) using all forms of recorded information as practical tools; (2) limiting of materials to those related to the work of the parent organization; and (3) expanding and extending reference services as a principal function. This special library model has already been adopted by numerous international agricultural information networks. User needs in agriculture suggest the necessity to extend models of this kind. From the user's point of view, information services should concentrate on answers and delivery and less on materials per se.

In order to accomplish this, however, users must play a role in the design of services. Ensuring that they do is another important role for librarians. There are some excellent examples in agricultural librarianship of services and networks which have actively involved users in their development and changed and enhanced services in response to them. Many have been mentioned in this article. The National Pesticide Information Retrieval System regularly involves users in annual user conferences. In assessing ten years of AGNET, the University of Nebraska founders James G. Kendrick and Thomas L. Thompson conclude that the main reason for AGNET's popularity and growth was "strict adherence to the policy of responsiveness to our users" (Murray, 1985, p. 110). AGNET's "library" of services was not the result of a theory or a design. Its staff simply listened to users and made every effort to supply what they needed.

Managers and providers of an information service—be it a secondary literature service, a library, or a specialized information center—must understand its particular clientele and its requirements. The importance of this cannot be overstated. The literature provides some useful reviews of user studies and other formal ways to gain understanding of users (e.g., Dervin & Nilan, 1986; Lancaster & Smith, 1979; Martin, 1976; and Powell, 1988). Cronin (1981) provides some general guidelines to follow in pursuing this objective. Cronin recommends that the aims in studying users should be to establish the precise size and character of the actual user population, to profile its information requirements in a systematic fashion, to attempt to match resources to needs, and to monitor effectiveness by encouraging user feedback. The important point, simply put, is that to gain sympathy for, and understanding of, users and to see the potential for services through users' eyes, one must go out and ask them what they need. Only market research will inform the interested librarian who is faced with a distinctive clientele of their special and no doubt highly individualized needs.

The danger of not investigating user needs is that users generally accept what is offered. Agriculturists are not considered to be particularly demanding (R. Farley, personal communication). However, the lack of criticism should never be interpreted as satisfaction by users. In fact, Oldman and Wills (1977) concluded from a study of business libraries that the more a library does for its patrons the more critical they are of it; however, the less it does for users the less critical they are (p. 122).

In order to learn first-hand about their users' needs and frustrations, librarians must move even further beyond traditional warehousing functions and take a proactive public relations role. Chen's study (1974) of 500 scientists found that the majority do not consult a librarian when in need of information. The proactive study at Cornell University's Mann Library seemed to break down barriers to the "awareness of information sources and services more than it affected physical or bibliographic barriers to information" (Coons et al., 1985). Another example of an assertive, public relations role for a library was that created by Drake (1978) following a survey which showed that Indiana veterinarians relied almost entirely on their own books and journals for information. She established and publicized a Veterinary Medicine Information Center at Purdue University which resulted in daily inquiries from the veterinary sector at large. In agriculture there has been a proliferation of services which can concentrate on providing service rather than on processing and maintaining collections. The success of these services has implications for the self-service library. As White (1979) notes, there are now commercial services whose purpose is to analyze and digest information in libraries and information centers. If librarians are truly concerned with users they must examine and perform this role.

The present survey makes it clear that agricultural librarians have a special pivotal role to play in the rapidly changing, increasingly important, and information-dependent agricultural sector of our society. To play this role, they must look in two directions at once—to their users for guidance and for a statement of needs, problems, and priorities; and to the world of information and technology for solutions and resources. It is their special responsibility to bring the two together. The task is challenging in its scope, urgency, and open-endedness, but what is known about agriculturists and about current trends can help focus their efforts.

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Collection Development, Selection, and Acquisition of Agricultural Materials

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ABSTRACT

THIS ARTICLE DEALS WITH collection development, selection, and acquisition of agricultural information materials for libraries. Collection planning and evaluation issues are first discussed. Included are collection development policies, the subject areas of agriculture, the RLG Conspectus, cooperative collection development, resource sharing, and preservation. These are followed by a discussion of selection and acquisition of agricultural materials, with numerous sources mentioned. A list of general suppliers and approval vendors is appended. This article is intended as a useful reference for librarians involved in collection development, selection and acquisition of the literature of agriculture.

INTRODUCTION

Libraries that acquire and maintain carefully selected collections of agricultural information materials perform a vital role. Delivery of agricultural information to a diverse clientele ranging from researchers to producers contributes directly to the production of food and fiber throughout the world. As with other pure and applied science subjects, however, the worldwide quantity and scope of available agricultural information materials is vast. Blanchard and Farrell (1981) estimated that there are more than 200,000 items published annually relating to biology and agriculture (p. 4). Given the exponential growth experienced for the scientific literature, this figure would be much larger today. Since it is uncommon for libraries to have unlimited means to acquire any and all materials, the ability to select and acquire relevant, focused collections serving a specific clientele or mission is crucial.

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Standard selection and acquisitions techniques applicable to other subject areas may be used for mainstream agricultural materials. However, because of the unique features of certain types of materials and sources, many challenges exist for librarians and agricultural specialists who select and acquire the collections including:

—the cross-disciplinary nature and breadth of the subject of agricultural information. Information relevant to agriculture cuts across many pure and applied subjects in the sciences and social sciences.
—levels of treatment of the subject. As with other applied science fields, information in agriculture must be supplied for the producer with little technical knowledge and the sophisticated scholar who is involved in the creation of new basic and applied research information. This factor is accompanied by the increasing complexity of research, product development, and specialization (Olsen, 1984, p. 141).
—diversity of source. Worldwide production of agricultural information outside commercial, university, and governmental channels contributes to the difficulty of identifying and acquiring relevant materials. Financial, political, and social factors contribute to problems of acquiring materials outside infrastructure sources.
—a rapidly changing information infrastructure. Changes in organizations and distribution methodologies require that attention be paid to access structures and policies. Olsen (1984) suggests that one is dealing with dynamic systems that are constantly changing information access and control structures. Year to year, "influence or control in one (federal) area may have transferred to another organization or group . . ." (p. 140). In recent years, as another example, the increasing privatization of U.S. governmental information contributes to the difficulty and cost of acquiring some materials.
—lack of current/unified assessments of the core materials in the field. Many good guides to the literature exist, but comprehensive work is needed to guide selection where agricultural information specialists are unavailable.
—suitability of materials for the existing technical and cultural environment. Building a collection on mechanized agriculture in a developing country may be unsuitable to the level of knowledge and mechanization.
—increasing difficulties in maintaining effort in many disciplines because of inadequate financial resources. Resources must be sufficient to maintain continuity of journal runs in a research environment or strategic decisions must be made.
—contribution of information technology and computing to the development of new formats and access techniques. Particularly, the CD-ROM technologies have expanded the total amount of information available and enhanced ease of access.

This article provides a general review of collection development, selection, and acquisitions techniques that apply to agricultural libraries. Necessarily, many of the approaches are common to all subjects and libraries of all types. Whenever possible, however, specific sources and techniques applicable exclusively to agricultural library collection development are presented.

Using a general framework of collection development, selection, and acquisitions, the article encompasses a comprehensive set of topics, including establishing a library mission, subject coverage of agriculture, collection development policies, evaluation and the conspectus, cooperative collection development, preservation, selection of current and retrospective materials, access to the unconventional literature and nonprint formats, acquisition of mainstream materials in all formats, acquisition of special problem materials, state publications, foreign sources, and gift/exchange materials. This article is intended to serve as a guide to librarians and technical personnel responsible for developing agricultural library collections.

COLLECTION DEVELOPMENT

Collection development, as defined here, is the systematic intellectual exercise of defining what library materials will be acquired by a library with reference to a well-defined mission or strategic programs. Collection development generally manifests itself in policies and written guidelines that direct the actual selection and acquisition of materials. Consequently, selection and acquisitions are treated here as procedural parts of the total collection building process.

Collection development in an agricultural library is largely a special application of general collection development principles and procedures. An important first step is to identify the mission or strategic thrusts of the institution or library. Concomitant definition of the subject matter of agriculture is important, as well. Subsequently, preparation of collection development policies and evaluation of collections should follow. Cooperative agreements relating to collection development and preservation are ancillary issues.

Collection development activities are pursued in all types of agricultural libraries, from the largest national libraries, such as Agriculture Canada or the National Agricultural Library (NAL), through land-grant university and other college and university libraries, to small specialized commercial, societal, or governmental establishments. Less formalized approaches will be utilized by individual horticulturalists, producers, hobbyists, and other private collectors of agricultural information.

Emphasis on components of collection development varies depending on the type of library. For example, precise selection and deselection are probably more important in the highly-specialized, small library while, in general, collection development policies and systematic collection evaluations are emphasized in the university setting. Cooperative agreements may be useful in libraries ranging from the small specialized library that cannot collect comprehensively to the largest national libraries where duplication with other national libraries is undesirable.

Missions and Strategic Planning

The understanding and statement of a library's particular mission is an important precursor to formalized collection development policy preparation and collection analysis. Further, since resources are never adequate to fully provide the information materials needed to support a library's mission, strategic planning is recommended.

Mission statements are simply articulations of a library's role and responsibilities to a parent organization and to the clientele of the library. "Provide agricultural information materials in required formats, encompassing plant pathology, animal science, horticulture, . . . in support of institutional undergraduate, MS and PhD programs" is an example of a way to begin. Detailed information about subject, format, and levels of acquisition may be included. Clearly, without an articulation of mission, it will be difficult to proceed with systematic collection development policies and procedures.

Many forms of incremental planning may be used by libraries. Goal/objective/strategy approaches are useful. However, since no library collects everything, and acquisitions funds are limited for most libraries, strategic planning is a responsible strategy for most libraries. Strategic planning utilizes many of the systematic characteristics of other planning techniques such as analyzing capabilities, assessing the environment, setting goals and objectives, and examining and implementing alternate strategies (Association of Research Libraries [ARL], 1984). However, strategic planning makes an attempt to concentrate resources in areas which make the most difference to the library's programs, rather than supplying proportional, inadequate funding to all programs. Strategic planning is a strategy and a way of thinking rather than a formula resource allocation technique. Strategic planning requires choices and may require the elimination or change of level of support for some subject areas. However, it strengthens the critical acquisitions efforts of the library if it is correctly applied. The Association of Research Libraries (ARL, 1984) provides examples of some university and academic library strategic plans. Moran (1985) provides a good introduction to strategic planning in higher education and in libraries.

Development of missions and strategic plans for libraries for purposes of collection development should take place in the context of the parent institution's mission and planning efforts. A library may develop an internal strategic plan without concurrent strategic planning by the institution, but a clear sense of the institution's role and scope must be articulated for strategic planning to be meaningful.

The Subjects of Agriculture

The range of agricultural subject matter has broadened continuously since the nineteenth century. In the early years, agriculture was equated with farming (Luchsinger, 1987, p. 1). As scientific methods and modern business practices were incorporated into agriculture, it became an increasingly interdisciplinary field within the applied sciences. Subject areas of interest to contemporary agriculturists have been described in several recent publications. Luchsinger (1987), from *Selection of Library Materials in Applied and Interdisciplinary Fields,* included "plant pathology, animal science, horticulture, engineering, food science and technology, agricultural economics, marketing, commodities, and general business, as well as the pure sciences of chemistry and biology" (p. 1). Lendvay (1980) links agriculture to "the fundamental principles of the physical sciences," and lists "botany, zoology, chemistry, mathematics, physics,...[and] also...geology, meteorology, economics, statistics and engineering" as source fields for agricultural activities and information (p. 1).

The RLG Conspectus (Research Libraries Group [RLG], 1989), discussed later, limits the agriculture subject division to the Library of Congress (LC) agriculture "S" class, but the supplemental guidelines for its preparation recognize that "agricultural research is largely a composite of many disciplines and subdisciplines of the social, biological and biochemical sciences" (RLG, 1989, Supplemental Guidelines, p. 1). Consequently, to comprehend the full range of subjects attributable to agriculture, one must consider the range of subject areas included in the National Agricultural Library's (1988) collection development policy where a more complete picture of the full scope of contemporary interests is provided (pp. 3-4).

As the U.S. library bearing national and international responsibilities for agricultural information, the National Agricultural Library collects comprehensively in many subject areas including general agriculture, agricultural societies and other organizations, animal and plant sciences, agricultural chemistry, economics, statistics, engineering, soils and soil conservation, forestry, food and nutrition, and rural sociology. Related materials are collected at the research level in such subject areas as biology, chemistry, physics, natural history, meteorology, ecology, and business management. Other subject areas collected are spread over the entire range of the LC classification system and include such diverse subjects as historical treatments of agriculture, botany, food, textiles, physical geography, water and hydrology, customs and folklore related to agriculture, food plants and animals, and rural education.

Materials are collected at NAL regardless of format when they meet subject criteria, although some types, such as doctoral dissertations available from University Microfilms and juvenile materials, are strictly limited. Expectedly, NAL houses its share of rare books and special collections. These include pre-1870 imprints and smaller collections of manuscript materials. Special collections include the James M. Gwin Poultry Collection, acquired in 1971, which contains over 1,000 volumes, as well as catalogs and files covering the field of poultry husbandry (Fusonie 1977, pp. 67-69).

The Mann Library at Cornell University has announced an important project to identify the core literature of the agricultural sciences for distribution to Third World nations in optical disc format ("Project at Cornell," 1989). For the project, agriculture has been divided into eight areas, including agricultural economics and rural sociology, agricultural engineering, basic plant sciences, applied plant sciences, animal science, economic entomology, forestry and silviculture, and soil sciences. Core publications of optimal value to Third World clients will be selected by experts, with completion by 1993. Once core literature is identified, full-text distribution can be considered. The Cornell project will be of value to agricultural libraries of all types for collection development and evaluation.

Collection Development Policies

No agricultural library can exhaustively collect the full range of agriculturally-related topics. Thus each library must establish collection needs and priorities based upon mission and strategic subjects. A written collection development policy provides a systematic description of needs, both for librarians and users. Generally, the need for a detailed collection development policy increases with the size of collections. We find, therefore, that most university libraries and large libraries such as the National Agricultural Library have written comprehensive policies. Since these policies serve multiple purposes, including being a foundation for cooperative agreements, many are based on the American Library Association's (ALA) "Guidelines for the Formulation of Collection Development Policies," which promotes comparability (Perkins, 1979).

The *Collection Development Policy of the National Agricultural Library* may serve as a model for agricultural libraries or collections (NAL, 1988). National libraries such as NAL bear the greatest responsibility to collect the entire range of agricultural information. As the NAL policy states: "The focus of collection development at NAL is on acquiring information important for the advance of agriculture regardless of its source, language, medium or form" in order to make it available to the entire agricultural community (Preface). Subsequent sections of the policy describe the mission of the library, purposes of the policy, and the coverage of the collection. Detailed statement of scope and collecting levels make up the major portion of the work (pp. 9-11). Because the NAL policy is based on the standardized format and terminology of the ALA guidelines, other libraries may use it as a reference when preparing policies for agricultural collections.

Currently many collection development policies are being revised to reflect widespread use of the RLG Conspectus as a collection evaluation tool. Librarians using the conspectus prepare detailed analyses of the levels of existing collections and a statement of current collecting levels by Library of Congress call number sequence. This information may then be incorporated into collection development policies to present a more detailed description of a subject area. Also, especially when budgetary constraints exist, libraries may add a desired collecting level to the description. This serves to guide the allocation of resources among disciplines, to support requests for additional funding, and to aid in allocation of available supplementary funding. The *Arizona State University Libraries Collection Development Policy Statement* (1987), illustrates some of these new features which are recommended in the second edition of the ALA *Guide for Written Collection Policy Statements* (American Library Association, 1989).

COLLECTION EVALUATION—THE RLG CONSPECTUS AND OTHER ISSUES

As previously noted, the RLG conspectus is becoming widely used for collection evaluation. By definition, a conspectus is a topical summary that provides an overall view or perspective. As applied by RLG to collection assessment, the conspectus provides a framework for analyzing collecting levels by LC call number sequence. This tool for analysis was adopted by the Association of Research Libraries to implement the North American Collections Inventory Project (NCIP). Consequently, by June 1988, about 80 percent of ARL libraries had completed at least part of the conspectus and had entered their data into the RLG Conspectus On-Line, a part of the Research Libraries Information Network (RLIN). This database provides an inventory of research collections held in the United States and Canada. NCIP purposes were defined in the *NCIP Manual* (Reed-Scott, 1988) primarily in regional and national cooperative terms, including: description and monitoring of collection strengths and weaknesses in North American libraries; the basis for cooperative collection development programs and for division of responsibilities for collecting, cataloging, and preserving materials and for interlibrary lending; and as a base for possible fund-raising activities (pp. 2-3). The manual also discusses local implementation issues. Possible local use of a library's conspectus results are: serving as a tool to assist in selection, preservation, and fund allocation; as a part of collection development policies; and as an aid for developing interlibrary cooperation projects (p. 49).

The National Agricultural Library acted as coordinator for the development of the agriculture division of the RLG conspectus. Librarians at NAL, Indiana University, and the University of California, Davis, completed the compilation of the agriculture division of the conspectus in 1985. By June 1989, the *Conspectus of Agriculture* incorporated the collections of about thirty-five libraries (RLG, 1989). They include all three U.S. national libraries and the British Library, as well as a good representation of northeastern and west coast libraries. Major land-grant university library collections, including Cornell, Purdue, Pennsylvania State University, and the University of Minnesota enrich the database. NAL also arranged for the agricultural collections of the non-ARL library at Kansas State University to be included in the conspectus data available online on RLIN. Clearly, some significant agricultural collections are held outside the ARL library sphere. As more land-grant and other libraries with strong agricultural collections complete the conspectus and submit results to the database, it will improve as an instrument for cooperation.

As part of NCIP, conspectus-based verification studies also have been prepared. They provide a standardized method for libraries to test the accuracy of local assessment as they include comparative data from other libraries. Verification studies for agricultural economics and genetics are available from the Association of Research Libraries, NCIP. A new version of the verification study for agricultural economics is under development at Mann Library, Cornell University, and is scheduled for completion in 1989. It is an outgrowth of the Mann Library core literature project ("Project at Cornell," 1989).

Evaluation of an agricultural collection need not utilize the conspectus, of course. Other methods of collection evaluation are described in the library literature and any of these could be chosen, depending upon the purpose to be served by the assessment. For example, Kaniki (1987) discusses the evaluation of the international agricultural collection of Pennsylvania State University Libraries. Evaluation techniques and their applicability to the project are discussed (p. 219).

Deselection should be mentioned as a part of evaluation and collection policy development. A decision to withdraw agricultural items or send them to a storage facility can be specified by policy. Decision criteria that describe what to withdraw under what conditions may be included in such policies.

Cooperative Collection Development

Cooperative collection development and resource sharing take place at all levels—local, state, regional, national, international—because they provide numerous benefits. Benefits may include access to a wider range of materials, more efficient and effective use of limited resources, reduced duplication, increased specialization and expertise at each cooperating institution, better client services, and improvement in relations among cooperating bodies (Evans, 1987, p. 5).

At the local level, libraries of different types may decide to share freely collections and services. For example, in Manhattan, Kansas, the Kansas State University (KSU) Library serves as a central research library for agriculture. However, libraries at the American Institute of

Baking, the Food and Feed Grain Institute of the U.S. Department of Agriculture, DPRA (Development, Planning, and Research Associates), and the KSU Post-Harvest Documentation Service all work together with the KSU Library to avoid duplication of collections of agricultural materials. This group of libraries represents university, commercial, governmental, and societal organizations. Numerous examples of such sharing at state and regional levels can be cited as well.

A long-standing national cooperative effort of special interest is that between NAL and the land-grant university libraries regarding the collection of state experiment station and cooperative extension service publications. In 1973, NAL and the land-grant libraries agreed to "collect, store and provide ready access to complete files of the major serial publications of state agricultural experiment stations, extension services and colleges of agriculture" (Garrett and Luchsinger, 1980, p. 111). The agreement led to the subsequent microfilming of many of these documents. In 1984, NAL initiated the NAL/Land Grant University State Agricultural Publications Program. The program expanded earlier agreements and recommended that university libraries supply NAL with full-level cataloging of serials, including analytics, through OCLC or RLIN, for inclusion in the AGRICOLA and AGRIS databases. Through vigorous selection and acquisition efforts, libraries' holdings and access to state agricultural publications have increased at both state and national levels.

The National Agricultural Library and the National Library of Medicine (NLM), working with the Library of Congress as appropriate, established several cooperative agreements defining the general division of collection responsibilities for veterinary medicine, human nutrition, and, most recently, biotechnology. Goals include the collection, retention, and preservation of all significant literature in these fields while reducing unnecessary redundancy at the national level. Through these agreements, at least one of the three libraries accepts national collection responsibility, usually at the comprehensive level, for each subcategory within the field. National responsibility is defined as an agreement "to maintain their collections at the stated collection level, provide services nationwide for other research libraries, and preserve the material dealing with the subject indefinitely" (Kulp, 1987). These agreements are further defined in separate publications from the libraries.

NAL collects in most areas of veterinary medicine, avoiding the areas to which NLM restricts its scope—i.e., comparative veterinary medicine, experimental surgery, the human/animal bond, and primatology. Both libraries collect in areas of laboratory animal medicine and technology, the veterinary profession, radiobiology, and veterinary public health (Kulp, 1985).

The NAL/NLM agreement covering human nutrition and related subjects was reached in 1987. It established twenty-six subcategories and collecting levels using conspectus terminology, with national responsibility carefully noted. To support respective user groups, both libraries collect more widely in human nutrition than in veterinary medicine. However, with careful detailing provided by the subdivisions, the libraries could identify specific areas in which one or the other could assume major responsibility (Kulp, 1987).

The biotechnology agreement involving NLM, NAL, and LC was completed in 1989. A draft ("Joint Collection Development Policy Statement," 1989) indicates that NLM will assume national collection responsibilities for most subcategories in biotechnology, which NLM designates as a core subject. NAL will collect at the research level with national responsibilities in plant genetics, cell culture, applications of biotechnology affecting plant and animal breeding and aquaculture, pest control of soil organisms and in food, and certain products of biotechnology directly concerned with agriculture and food science. LC also will collect extensively in the field—at the research level for most categories—although that library will minimize collecting in the areas of clinical medicine and technical agriculture (p. 2). The final agreements are to be published in NAL and NLM newsletters.

PRESERVATION

Preservation, an ancillary but important topic of formalized collection development activity, deserves mention because of the fragile nature of many agricultural publications. Thus, agricultural libraries may wish to include preservation with formalized collection development policies. The decision to preserve or discard a publication currently owned may be as important as the decision to purchase a new item.

The subject of preservation has received much attention in libraries of all types over the past few years and is an area of expanding interest and expertise. Preservation as a general topic cannot be adequately treated here. See Kovacs (1987) for an overview of preservation in science and technology libraries. Consequently, the focus here will be only on those preservation issues which most affect agricultural collections.

As with other scientific and technical disciplines, a significant portion of agricultural collections is composed of journals, leaflets, and other unbound materials. Preservation demands, generally, that such materials be promptly bound together. Otherwise, shelving and other physical stresses will, over time, result in destruction. Binding is particularly important in limiting exposure of acid process paper to environmental conditions that may result in deterioration. Collection development policies may thus include directions for binding of materials by format and condition. As an alternative to binding, microform backfiles may be purchased and current paper issues may be discarded as the microform edition is received. However, if backfiles are retained in microformat rather than paper, binding costs may be offset by the cost of the additional microform subscriptions. Microformat and other non-book materials have their own special preservation requirements which are sometimes more rigorous than those for paper.

Some paper publications present special problems as well. As noted by Kulp (1988), chief of Collection Development at NAL: "A very high proportion of agricultural publications are published by poor societies and poor governments with the intent of free distribution" (p. 3). To reduce costs, these publications are frequently issued on cheap, highly acidic paper which quickly becomes brittle. Items often vary widely in size and format within series and may be revised frequently. These characteristics make commercial binding difficult and expensive and may rule it out altogether. Agricultural librarians will immediately think of the essential but frustrating agricultural experiment station, extension service, and governmental agencies' publications which fit this description. Alternative storage techniques for loose issues include the use of princeton files or boxes. However, misfiling, loss, sagging, and folding may quickly become major problems for stacks management and preservation staff. Adequate pamphlet binders and enclosures can be produced for selected materials with minimal equipment and supplies by in-house book repair or preservation units. This solution is increasing in popularity, although costs must be monitored. Other alternatives include placing materials in vertical files or segregating them in special collections where maintenance standards can be enforced.

The National Agricultural Library is currently attacking the preservation problem in all of its many manifestations. In the article previously mentioned, Kulp (1988) describes NAL preservation planning as a "consultant-assisted self-study of the current preservation status of the Library and the development of plans for implementing preservation activities at NAL" (p. 1). The major problems faced by NAL are recorded in a draft of the *Preservation Plan for the National Agricultural Library* (NAL, 1989). NAL's condition survey indicates that more than 50 percent of the collection is disintegrating including about 27 percent which is already brittle. Special funding is recommended for the program. It also recommends that additional attention be immediately paid to serial binding and a disaster plan. A five-year plan for phasing in other preservation activities is outlined in detail. This outline includes recommendations concerning: the assessment of the physical condition of the materials, the prioritization of materials for preservation treatment, the implementation of preservation procedures, the improvement of environmental conditions, and staff education. Cooperative preservation activities with other libraries also are discussed. While agricultural libraries of all types may look to NAL for leadership in the preservation initiative, and especially as a source of last resort, individual libraries must initiate preservation programs that address local unique problems.

Selection

Sources for Selection and Collection Evaluation

An excellent starting point for collection development and selection sources in agriculture (or a particular subject field within agriculture) is a guide to the literature. The guides to the literature and, more broadly, guides to information sources, can quickly give the novice a broad overview of the discipline, indicate what types of information are used, and list and describe the most important indexes, reference books, serials, and other publications. Such guides also can serve as useful collection evaluation tools for someone who is already familiar with the literature. Two major guides are Blanchard and Farrell's, *Guide to Sources for Agricultural and Biological Research,* and Lilley's, *Information Sources in Agriculture and Food Science.* There are some guides that cover narrower disciplines within agriculture, such as Isaacson's, *Gardening: A Guide to the Literature;* Morgan's, *Keyguide to Information Sources in Agricultural Engineering;* Szilard's, *Food and Nutrition Information Guide;* and Vallentine and Sims's, *Range Science: A Guide to Information Sources.* In addition, there are several information guides to the life sciences and, more broadly, science and technology, that cover agriculture and related materials. Finally, there are the multidisciplinary guides such as Sheehy's *Guide to Reference Books* and *Walford's Guide to Reference Materials* that include basic reference sources for agriculture. For a recent brief overview of selection of all types of agricultural literature in libraries, see Luchsinger's (1987) chapter "Agriculture" in *Selection of Library Materials in Applied and Interdisciplinary Fields.*

For purposes of collection development and selection it may be helpful to consider several of the major producers, organizers, and suppliers of agricultural information: the U.S. Department of Agriculture (USDA), the Food and Agriculture Organization (FAO) of the United Nations, CAB International (formerly Commonwealth Agricultural Bureaux), the Commonwealth Scientific and Industrial Research Organization (CSIRO) of Australia, and Agriculture Canada. Most of these organizations publish a wide variety of agricultural materials including serials, monographs, reports, booklets, and pamphlets. A few of their specific publications are mentioned elsewhere in this article. For further information on these organizations and their publications one can consult directories such as *Agricultural Research Centres,* the guides to the literature by Lilley, and Blanchard and Farrell, and several of the other references listed at the end of this article.

Retrospective Selection

For retrospective evaluation and selection, the agricultural guides to the literature, several of which have been mentioned, are reliable and detailed sources of information. Selecting items for purchase may be an easier task than acquiring them as some "classic" works may no longer be in print.

Consulting bibliographies is a standard method of selection in all areas, and agriculture is no exception. The national bibliographies, such as *British National Bibliography, Australian National Bibliography, Canadiana,* and *Deutsche Bibliographie,* are good sources for non-U.S. publications. Besides the national bibliographies and the bibliographies and/or literature guides appearing as articles in various library journals (and occasionally in science and agricultural journals), there are bibliographies on various topics in agriculture, both narrow and broad, that have been published as monographs. Tucher's *Agriculture in America, 1622-1860,* although not large, is good for very old books. It is actually a compilation of the holdings of several institutions. *Pure and Applied Science Books, 1876-1982* is a six-volume set arranged by more than 56,000 Library of Congress subject headings and includes many works dealing with agriculture and related areas. *Books for College Libraries* (3rd ed., 1988) covers a core collection of 50,000 titles in all subject areas for undergraduate libraries and includes a section on agriculture. Prior editions of this work were published in 1967 and 1975. Another possibility is the creation of an individualized bibliography on a specific topic using an online database such as AGRICOLA, AGRIS, BIOSIS, and Chemical Abstracts and restricting the search to a particular document (publication) type or types, such as monograph, conference proceeding, or report. A search using Library of Congress subject headings is possible in the RLIN database. The results of the online search, of course, will be determined in large part by the degree to which the database permits refinement of searching by document type, and also the quantity, quality, and availability of items retrieved. One advantage of this approach is the capability of hand-tailoring a bibliography in which the searcher defines the subject, document type, dates of coverage, languages and other characteristics.

In addition to bibliographies, library catalogs can be used as selection tools. The *Dictionary Catalog of the National Agricultural Library 1862-1965* is an important source; it was continued by the *National Agricultural Library Catalog. The National Union Catalog* of the Library of Congress in its various forms is also of value.

Gifts can be an important source of retrospective materials to add to an agricultural collection. Selectors should remain alert to private holdings as a means of acquiring older materials. Often gift collections will include older, out-of-print items that are not readily available elsewhere. The acquisition of gift materials is discussed further later.

SELECTION OF CURRENT MATERIALS

There is no clear-cut division between retrospective and current selection sources. However, current sources listed later will be, for the most part, tools not previously mentioned. Current selection sources can be divided into two general categories—serials and monographs. However, there also will be necessary overlap between these two formats.

As in most of the sciences, serials, especially journals, are of relatively greater importance to users of agricultural literature than monographs. Sources for selection of serials include reviews and/or listings appearing in library science publications such as *IAALD Quarterly Bulletin, Agricultural Libraries Information Notes, Serials Review,* and others. Reviews, listings, and advertisements also appear in agriculture and other science journals. *Nature,* for example, has an annual new journals issue. Another readily available source for selection is the general category of publishers' catalogs, brochures, and announcements; it is not difficult to get on the mailing lists for such items. In addition, there are catalogs and other services available from subscription agents. Lists of core serials in agriculture can be obtained from indexes such as *Biological and Agricultural Index* and *Science Citation Index. CAB International Serials Checklist* is an extensive alphabetical list of agricultural serials and includes separate sections for annual reports and conference proceedings. There are also the standard serials reference publications such as *Ulrich's International Periodicals Directory, The Serials Directory,* and *The Standard Periodical Directory,* all of which provide subject access, pricing, and publishers' names and addresses. *Agricultural and Animal Sciences Journals and Serials: An Analytical Guide* by Jensen et al. is a recent annotated collection of major serial titles.

Serials holdings lists of other libraries, both published and unpublished, may be available. *Serials Currently Received by the National Agricultural Library, 1975: A Keyword Index* in print and the later NAL serials lists (title and keyword) on microfiche may be of some use, although there is no breakdown by disciplines within the broad field of agriculture. *AGLINET Union List of Serials* from the FAO provides yet another alphabetical list of titles in agriculture. Likewise, the Library of Congress' *Union List of Serials* and *New Serial Titles* arrange items alphabetically and not by subject.

Bibliometric methods can be employed as a selection aid. One good example is *Journal Citation Reports (JCR),* produced by the Institute for Scientific Information, and appearing annually as a part of *Science Citation Index. JCR* provides statistical data for serial titles: impact factor, immediacy index, and half-life. The journal rankings section of *JCR* groups agricultural serials as follows: agriculture; agriculture, dairy and animal science; agriculture, soil science; agricultural economics and policy; and agricultural experiment station reports. It then ranks the agricultural serial titles within each of these groups by their impact factor. Impact factor is a calculation of the frequency with which articles appearing in a particular serial are cited. *JCR* can be used (cautiously) as a selection aid, keeping in mind the needs of the institution.

A ready source for selection of monographs (and serials) is the wide array of publishers' catalogs and mailers. Commercial publishers of agricultural topics include Academic Press, CRC Press, Wiley, Elsevier, Oryx Press, Timber Press, Rodale Press, and others. In addition to the commercial presses, society presses such as the American Society of Agricultural Engineers (ASAE), American Association of Cereal Chemists, American Society of Agronomy, American Chemical Society, American Phytopathological Society, plus many others, are of great importance. Several university presses publish books of interest to agricultural libraries—e.g., Iowa State University Press and Texas A&M University Press. Catalogs and lists from booksellers represent another source, and they may offer out-of-print items. An example is *agAccess Agricultural Book Source* published by agAccess, a Davis, California company specializing in agricultural and horticultural books including out-of-print items. A second example is *Catalog of Professional Horticulture Books & Video Tapes & Audio Cassettes,* produced by American Nurseryman, Chicago, Illinois. Another catalog is the *UNIPUB Bulletin of New Publications.* UNIPUB, Lanham, Maryland, is the U.S. distributor for General Agreement on Tariffs and Trades (GATT), Food and Agriculture Organization of the United Nations, Center for Agricultural Publishing and Documentation (PUDOC), United Nations Educational, Scientific, and Cultural Organization (Unesco), and other organizations.

The *American Book Publishing Record (ABPR)* and *Weekly Record* are an effective way of keeping up with materials currently published in this country. The *ABPR* is especially useful because it provides ready subject access through its Dewey Decimal Number arrangement. The various "books in print" works can be used for both current and retrospective collection: *Books in Print, Paperbound Books in Print, Sci-Tech Books and Serials in Print, Canadian Books in Print,* and *International Books in Print* are a few examples.

Review publications, including indexes to reviews, while providing access to critical or descriptive reviews of books, have the disadvantage of not being seen until months or years after the book is published. There are the standard well-known titles that cover all disciplines such as *Choice, Booklist, Book Review Digest, Book Review Index,* and *American Reference Books Annual.* Then there are others that cover the sciences and technology and include agricultural and agriculturally-related books—e.g., *Science Books & Films, Aslib Book List, Technical Book Review Index,* and *Science and Technology Annual Reference Review* are examples.

Separate sections of some indexes and abstracts are allocated for books or book reviews. The H. W. Wilson Co. indexes cite reviews of books; *Biological and Agricultural Index* is the most relevant, but others, such as *General Science Index* and *Applied Science and Technology Index,* will also contain items of interest. The list of citations to the reviews appears at the back of each issue and is cumulated annually. No summary of the review is provided. Books, reports, and conferences are grouped separately in each issue of the various CAB abstract journals; an abstract is provided for each item. *Biological Abstracts/RRM* also groups books separately, provides abstracts, and lists individual chapters for edited works.

An excellent source for informed, critical, and sometimes lengthy reviews is the agricultural or science journal. *American Journal of Agricultural Economics, American Journal of Alternative Agriculture, Aquaculture* (Elsevier), *Economic Botany, Food Technology, HortScience, Journal of Range Management, Plant Pathology,* and *Tropical Pest Management* are a few examples. The more broadly focused journals such as *Science, Nature, American Scientist, New Scientist, BioScience,* and *Quarterly Review of Biology* regularly review books of interest to agricultural libraries.

New acquisitions lists of libraries are another possibility. The New York Public Library's *New Technical Books* is a selected list of new titles received, annotated, and arranged by Dewey Decimal Number. Some libraries may prepare in-house acquisitions lists that they would be willing to share or trade with other libraries.

A long-available service from the Library of Congress is the provision of LC cards to libraries. Included are items not yet published as well as those recently published. Government documents, including USDA publications as well as commercial and society press books, are also included.

The best places to look for theses and dissertations available for purchase are *Dissertation Abstracts International* and *Masters Abstracts International,* both produced by University Microfilms International (UMI), Ann Arbor, Michigan. The dissertations are neatly arranged by subject categories such as: agriculture, agronomy; agriculture, plant pathology; chemistry, agricultural; entomology; and engineering, agricultural. UMI order numbers are included with the abstracts for most items. It would not be difficult to generate a list of dissertations for selection purposes using CD-ROM or an online database.

For selection of government publications (serials as well as monographs) the following indexes are important: *Monthly Catalog of United States Government Publications* (the USDA is a large producer of documents, many of which are also accessible through *Bibliography of Agriculture* and the AGRICOLA database), *Monthly Checklist of State Publications,* and *FAO Documentation: Current Bibliography* (for an explanation of the publications of the Food and Agriculture Organization of the United Nations and their acquisition, see David Lubin Memorial Library, FAO [1986]; Moody [1986]; Phillips [1973]; Sinkule and Moody [1987]; and Van De Voorde [1987]).

Other options available to agricultural librarians are the various approval plans and form plans offered by several domestic and foreign vendors. An approval plan is based upon an agreement between a library and vendor. The vendor acquires books from many publishers and distributes them to a library according to a preestablished profile where parameters such as subject, price, country of origin, and language are included. The library may accept or return any book depending on an assessment of its appropriateness for the collection. A form plan utilizes approval plan and profile concepts except that forms are sent instead of books. A library selects from information contained on the form and submits an order. Upon receipt of the order, the vendor supplies the book. The advantages and disadvantages of approval plans have been debated for years (DeVilbiss, 1975; Kautz, 1985), but many libraries combine an approval or form plan in some way with manual selection to ensure thorough coverage of the literature. Futher explanations of approval and form plans are given later.

Finally, the selection process can include word-of-mouth information and requests from fellow librarians, faculty, students, staff, or other library patrons. Librarian visits to bookshops, newsstands, and other libraries may occasionally turn up desirable items not otherwise identified.

Nonconventional Literature

For "grey" or "fugitive" literature, direct contact with the publisher, if known, may be the most effective way to obtain the desired material. Fugitive or grey literature is defined as "literature which is not issued through conventional commercial publishing channels. Typical of this type of literature are reports, theses, conference proceedings and translations not published commercially, official documents issued in limited numbers, technical recommendations or rules, etc." (Chillag, 1982, p. 3). If the publisher is an agricultural society, association, or other organization, directories such as the *Encyclopedia of Associations, Gale Directory of Publications* (formerly *Ayer*), and *Agricultural Research Centres,* or a guide to agricultural literature/information sources can be of great help. For a broad overview of the grey literature of agriculture, see Chillag (1982).

The agricultural experiment station and state extension publications are often considered fugitive literature because, until recently, there has been no coordinated effort on a national scale to collect and index these documents. Many are irregular series; monographs also are published. For acquiring specific publications, the most direct method is to check with the publications office of the agricultural experiment station or extension service to determine if the item is still in stock and order directly; there is often no charge. It may be possible to establish an exchange agreement with the publications office for specific series titles. The *Directory of Professional Workers in State Agricultural Experiment Stations and Other Cooperating State Institutions* is a U.S. government document that is updated periodically and includes telephone numbers and names for many of the publications departments (USDA, 1987). The state experiment stations also are covered in *Agricultural Research Centres*. Another helpful guide is a list of current holdings of major agricultural experiment station series of the NAL entitled *Selected State Publications Held by the National Agricultural Library*. For retrospective collection development, many land-grant universities now have large portions of their agricultural experiment station publications on microfilm and they are available for purchase by any library. This has come about as a result of the NAL Cooperative Agreement for microfilming which was initiated in 1974. Spaulding Company, Stoughton, Massachusetts, is presently offering land-grant agricultural publications for approximately forty states on microfilm, and a few other companies also are selling the microfilmed documents. For further reading on the state agricultural publications, including history, access, the microfilming project, and recent developments, consult Bailey (1988), Garrett and Luchsinger (1980), Mathews (1987, 1988), and Thomas (1988).

Published conference proceedings can range from well-known and well-indexed to fugitive literature in the extreme. It may be difficult to determine whether or not any papers presented at a conference were actually published, or whether only selected papers were published, or if all papers were published. In some cases, only abstracts of the papers are published. Some commonly-used indexes that help track down proceeding literature are: *Directory of Published Proceedings* (InterDok), *Index to Scientific and Technical Proceedings* (Institute for Scientific Information), and *Index of Conference Proceedings Received* (The British Library).

Some government documents may be considered fugitive literature: publications of USDA regional offices, state agricultural department publications (many should appear in the *Monthly Checklist of State Publications*), documents produced by foreign governments, especially below the national level, and publications of various agriculture departments within universities that are not distributed as experiment station or extension publications. See Curren's (1980) article for information on Agriculture Canada publications, including establishing exchange agreements.

Reports prepared by corporations, nonprofit organizations, and other groups may not be widely distributed. Some are accessible through CAB, AGRICOLA, AGRIS, CAS, and other databases or indexes. If the research is government sponsored, the NTIS online database or the printed *Government Reports Announcements and Index* should be consulted. The previously mentioned *CAB International Serials Checklist* includes a separate section for published reports related to agriculture.

Translations are another category of fugitive literature; it may be very difficult to determine if a monograph, report, or article was ever translated. Online databases mentioned in the previous paragraph can be checked, as well as the translation indexes. In addition, the National Translations Center at the Library of Congress provides services that may help.

Finally, there are small miscellaneous items, such as newspaper clippings, special newsstand issues, informative brochures, promotional materials and catalogs, and so forth. Some of these types of materials can be selected from H. W. Wilson Company's *Vertical File Index,* often at no charge or for a modest price. Other items may be picked up at conferences, conventions, and fairs. Most of these materials are not suitable for integrating into the main collection but could be kept in a vertical file or perhaps could become part of a special collection.

Selecting Nonprint Formats

Some categories of nonprint formats for agricultural materials are microforms, audiovisual, and computer software. Microforms can be selected using publishers' catalogs, *Guide to Microforms in Print,* and *Microform Review* (a bimonthly journal). *Guide to Microforms in Print* is arranged by broad subject categories and includes numerous agricultural items such as those of the USDA, some foreign agricultural documents, and hundreds of state agricultural experiment station series, listed under the names of the states. The ASAE *Technical Papers* of the summer and winter meetings is an example of a society publication available in microform. Most FAO publications can be purchased on an annual basis as a microfiche set at a reasonable cost.

The traditional sources can be checked for appropriate audiovisual materials: *AV Marketplace* (a directory of companies), *Media Review Digest, Video Source Book,* the various NICEM (National Information Center for Educational Media, now AV Online) indexes, and others. Some review publications such as *Science Books and Films* also cover films and video.

A relatively new area for collection development is that of computer software. Information and reviews appear in library, computer, and agricultural and science journals. *The Software Catalog,* published by Elsevier in several editions, provides subject access to programs. Demas et al. (1985) provide an interesting account of the development of a microcomputer software collection in an agricultural library. At the time the article was written, the library had a collection of approximately seventy titles, not restricted to agricultural subjects, with generic software also selected if determined to meet the special needs of the library's users.

The availability of many databases in CD-ROM as well as online and print versions requires selectors to make hard decisions. Several agricultural databases (or databases of interest to agricultural libraries) have been on the market for some time in CD-ROM format, and others will surely follow. Some of special interest are: AGRICOLA, CRIS, Agribusiness USA, Biological and Agricultural Index, Life Sciences Collection, Aquatic Sciences and Fisheries Abstracts, Science Citation Index, and MEDLINE. In addition to the bibliographic databases, there are some full-text CD-ROM projects being conducted by the National Agricultural Library, the Consultative Group on International Agricultural Research (CGIAR), and others. It appears that CD-ROM is definitely here to stay; one obvious weakness is lack of timeliness compared to online services. However, some systems allow the CD-ROM searcher to save the strategy and log on and execute that strategy in the online database to get the most recent records.

Acquisitions

While the acquisition of mainstream agricultural materials is largely routine and can be achieved without special efforts or procedures, some materials can be very elusive and difficult to obtain. Such materials present special challenges to the acquisitions staff and a library's suppliers.

Current Mainstream Publications

Although the merits of approval plans are still debated, many libraries find them to be a satisfactory method of acquiring current materials. Approval vendors routinely cover the trade and university presses; some handle more small and societal publishers than others, which can be a factor in selecting an approval vendor. A brief survey conducted at Kansas State University (unpublished) of Blackwell North America's (BNA) approval program coverage and cost studies for 1983/84 through 1987/88 reveals an average of 328 new agricultural and related books treated per year.

Any single library's profile probably would eliminate some or many of these, of course, depending upon the level of comprehensiveness, but a properly adjusted profile should yield materials that are in scope with a minimum amount of effort on the part of librarians and acquisitions staff. Approval plans, however, are only a single phase of the acquisition effort; they are not a substitute for careful selection by librarians and/or other selectors.

Establishing one or more form plans with vendors, either in conjunction with an approval plan or independently, is another easy means of acquiring materials. These plans, which operate via profiles that can

Summary of Blackwell North America Approval Coverage

Primary Subject	*1983-84*	*1984-85*	*1985-86*	*1986-87*	*1987-88*
Agriculture	204	225	248	272	259
Forestry	31	21	32	30	18
Animal Husbandry	67	48	47	86	54
Total	302	294	327	388	331

range from simple to complex, provide a notification of available materials matching the library's interests. Whereas most libraries generally have a limited number of approval plans, form plans can be less restricted since they require no financial commitment to the vendor. These plans can be particularly useful in obtaining notification of foreign materials. Combining one or more form plans with approval plan coverage and careful review of publishers' catalogs and brochures can provide basic access to current trade and societal monographs.

Serials may be acquired directly from their publishers or through a vendor, such as EBSCO Subscription Services, the Faxon Company, or Blackwell North America. Subscriptions and standing orders are continuing expenses and budgets must account for annual payments plus any price increases imposed by the publisher or agent. Much has been written lately about journal price increases, the proliferation of new titles, and the consolidation of publishing into the domain of large commercial publishers. The 1989/90 *Bowker Annual of Library and Book Trade Information* indicates the average 1988 price of U.S. agricultural periodicals is $33.56 which is well below prices in subjects such as chemistry and medicine. This price, however, represents a 29 percent increase over 1985 prices, and a 190 percent increase over 1977 prices. Since agricultural collections rely heavily upon periodicals for essential coverage, these price increases must be factored into the overall budget. It is the librarians, often with other selectors' or patrons' input, who must make the difficult decision of which titles to buy and which to disregard (or cancel).

As particular serial titles or publishing agencies are identified as being important sources of materials, standing or blanket orders can be initiated to obtain the titles or agency's publications on a continuing basis. Standing orders, established on a title-by-title basis either directly or through a vendor, can be monitored relatively easily if numbers within the series are issued sequentially; erratic series, on the other hand, present more of a challenge in making certain all items are being received. Blanket orders for all or a subset of a publisher's output are more difficult to monitor for completeness since the library does not generally know in advance what monographic titles will be received; serial titles are more predictable as long as they continue to be covered by the blanket order agency.

Because of its special importance as a source of agricultural materials, the Food and Agriculture Organization of the United Nations deserves special mention. FAO sale publications are distributed in the United States and Canada exclusively by UNIPUB and are available on standing order either on a comprehensive or selective basis. Periodical, microfilm, and free publications are available directly from FAO in Rome. An alternative means of distributing FAO sale publications to U.S. land-grant institutions' libraries through the U.S. Department of Agriculture's Office of International Cooperation and Development was described in Van De Voorde's (1987) article. This distribution system, however, has recently been discontinued and will be replaced by direct distribution from FAO Rome via the U.S. FAO Liaison Office, Washington, D.C. This new distribution system will be limited, at least in the initial stages, to the libraries of the land-grant and 1890 universities established by the Morrill Acts of 1862 and 1870 (D. Brydges, personal communication, June 1989).

Special Problem Materials

In his summary of the suppliers of U.S. agricultural and technical information, Olsen (1984) estimates that the commercial sector is responsible for 50 percent of the total informational output, with universities and the educational community responsible for about 30 percent of the total, and governmental agencies issuing the remaining 20 percent (p. 139). Olsen's definition of "commercial sector" includes not only commercial publishers, but also corporations, commodity exchanges, financial and economic marketers, and other commercial firms that work with farmers directly or indirectly. Some of these latter commercial types, as well as certain university and governmental publications, provide a special challenge in acquiring agricultural materials (p. 138).

Fugitive or grey literature presents two difficult problems: first, becoming aware of its existence (previously discussed) and, second, how to acquire it; estimates on the worldwide output of this type of material can be as high as 200,000 items per year, and a high percentage of agricultural materials produced in developing countries falls into this category. Unless the item is included in an agricultural supplier's catalog or is available from a clearinghouse such as NTIS, even the most dogged efforts by the library staff or its vendor can end in frustration; sources are difficult to locate and, if located, the response to an order frequently is "no longer available." Success in obtaining material often involves prepayment or establishing deposit accounts which can be a problem in some institutions.

In addition to grey literature, there are special nonbook materials such as audiovisuals and photographs that are important in the area of agriculture and its related fields. More often than not, these items are produced by small agencies or academic departments and are not available through usual trade channels. Ordering them can result in the same frustrations encountered with grey literature: difficulty in locating the source, availability, or advance payment. Often these sources are not accustomed to library business practices, and thus invoicing and payment can also present special problems. There are some vendors that will handle these special nonbook orders, generally for a fee. It must be the library's decision whether the convenience justifies the added expense.

As mentioned earlier, many conference proceedings fall into the category of grey literature; they are not published commercially and thus can be very elusive. In an effort to improve access to these materials, the National Agricultural Library is currently developing a database which will include information on future conferences; utilizing the information, staff will track the availability of the proceedings (C. Early, personal communication, June 1989). This solution on the part of NAL is a creative—albeit labor intensive—effort to obtain difficult materials.

Compared to the noncommercially published proceedings, those published commercially are much more readily obtainable through vendors or the publishers. Print runs for these materials, however, are often very small, sometimes being as few as 750 copies according to Catherine Flanagan (1985), representative of Elsevier Science Publishing Company, at the 1985 ALA Preconference on "The Business of Acquisitions." The practical implication of this is that these materials go out of print very rapidly. Obtaining them can be slow, costly, or impossible through the out-of-print market.

Another important but particularly difficult category of agricultural material is state publications, particularly the output of state departments of agriculture and land-grant institutions' colleges of agriculture, agricultural experiment stations, and cooperative extension services. As mentioned previously in this article, NAL's cooperative agreements with land-grant university libraries to obtain university and state agricultural materials have greatly enhanced the accessibility of these materials. These items are accessible via the AGRICOLA database and available commercially in microform from the Spaulding Company in Stoughton, Massachusetts.

The most direct means of acquiring publications from the land-grant universities is contacting the agencies or offices individually to get on their mailing list or to establish an exchange. One source for current names and addresses is the *Supplement to Directory of Professional Workers in State Agricultural Experiment Stations and Other Cooperating State Institutions* (USDA, 1988), which is available from the U.S. Government Printing Office.

Out of Print

One problem in working with retrospective core lists for any subject discipline is that many of the titles listed may be out of print. Unfortunately, however, this problem is often encountered when trying to obtain newer materials as well.

Since the U.S. Supreme Court's Thor Power Tool decision in 1979, which increased the tax liability on commercial companies' inventories, librarians and book dealers have watched in dismay as publishers declare titles out of print and sell off their backlist inventories. At the same time, print runs for scholarly materials are generally modest due to the relatively small market (Flanagan, 1985). Although a recent study by

Selth (1989) refutes the common perception that books are going out-of-print more quickly now than previously, it is undeniable that this continues to be a problem in acquiring all but the newest materials.

Foreign Materials

Obtaining materials from Canada and Western Europe, with their well-developed publishing industries and book trade, presents no special problems for acquisitions staff. Other areas of the world, however, have different characteristics which make acquisitions more difficult.

Generally, mainstream journals and serials from the Soviet Union can be purchased by subscription or standing order without too much difficulty; although titles are frequently behind in publication, the billing is prompt so that receipt often lags far behind the payment. Monographs are out of print almost as soon as they are published which virtually requires that orders be placed prior to publication; a prompt order, however, does not mean prompt delivery; the title may not come for years or may never be published at all. The periodical *Novye Knigi SSSR*, published in Moscow by the Soviet Gosudarstvennyi Komitet Po Pechati, provides prepublication announcements for Soviet titles. Exchange agreements with Soviet governmental agencies can be particularly frustrating since they tend to be very sensitive to inequalities and alternately wish to match value for value, issue for issue, or even page for page.

In her paper entitled "Latin American Acquisitions: A Continuing Challenge," Repp (1989) describes the publishing industry and book trade in Latin America as generally underdeveloped, with export and foreign monetary exchange regulations that can be highly restrictive; governmental upheaval tends to destabilize the situation even further. Many book dealers are small operations which tend to distrust strangers, thus practically requiring a library to establish contacts in each desired country or to deal through an agent. One important source of information about Latin American suppliers is the *Directory of Vendors of Latin American Library Materials* (Block & Karno, 1988).

With a few notable exceptions—such as Japan, Singapore and Hong Kong—Africa and Asia are also largely characterized by an underdeveloped publishing industry and book trade. Here, too, political conditions can often complicate transactions. Unless a library can find an acceptable supplier who deals with a particular country, acquisitions efforts are often handicapped by language, currency conversion, advance payment, and the gap of distance and culture.

The Library of Congress Overseas Operations Office has a special acquisitions program which covers sixty third world southern tier countries. This program is open to any library that wishes to participate. Participants establish a profile of their subject and geographic scope and deposit money into a special deposit account. Library of Congress staff in six regional offices (located in Jakarta, New Delhi, Karachi, Cairo, Nairobi, and Rio de Janeiro) select and purchase materials in those and neighboring countries. Each regional office also produces a monthly or bimonthly accessions list which is available to participants.

Exchange

Another important means of acquiring vital agricultural materials is the process of exchange. By supplying copies of its own agency's serial publication(s) to other agencies, a library can obtain the other agencies' publication(s) in return. Often the materials received in this manner would be more difficult to obtain through other means, and there are some publications (e.g., house journals, unpriced items) that may be available only through exchange. These arrangements need not always be reciprocal, however. Many government and university agencies, such as agricultural experiment stations at land-grant universities, will distribute their publications upon request. Exchange agreements are generally informal, usually requiring only a letter to initiate. They can be difficult to maintain over extended periods as staff and procedures change, unless closely monitored and carefully documented. Another pertinent aspect of exchanges is that the library may incur costs for subscribing to multiple copies of its own publication(s), in addition to mailing, staff, and other costs, and thus these agreements should be reviewed periodically to make certain the cost/benefit ratio remains advantageous. A more complete treatment of exchanges and gifts can be found in Magrill and Hickey (1984).

Gifts

Gifts, although often a mixed blessing, can be similar to exchanges in terms of the type of material received: corporate annual reports, research reports, and other esoteric items that come unsolicited in the mail. Additionally, used books and periodicals generally arrive by the boxload from agency departments, faculty, students, and members of the community at large. Although much gift material can be of limited usefulness, some of it is highly pertinent. Staff involved with gifts can spend much time sorting through unwanted material to identify those items that the library wishes to return. Fortunately, not all gifts are in this category; libraries are at times recipients of special items or collections that are of remarkable value. Donors of these items may approach a library directly, either due to the donor's affiliation or the library's reputation. However, in many cases library staff must take the initiative to locate and solicit these materials. This solicitation requires individuals who are externally involved and alert to opportunities as well as possessed of the negotiating skills necessary to land the prize.

Conclusions and Trends

Collection development, selection, and acquisition of agricultural materials for agricultural collections can be a daunting task due to unique features and unusual challenges posed by the nature and sources of the materials. However, if agricultural librarians and other selectors approach the task systematically, with increased attention to policies governing selection, improved sources for guiding selection, and use of organized acquisitions techniques appropriate to the type and source of material, good results are obtained. Future trends expected for collection development and acquisition of agricultural materials are summarized here.

Collection development, or the intellectual exercise of defining institutional mission, evaluating collections, and specifying what will be acquired at what level, has been discussed. Clearly, with acquisitions funds increasingly in short supply, a library must develop careful policies that govern the acquisition of materials. As suggested, the library must first determine its mission or how it serves its primary clientele. It follows that "strategic planning" for collection development must be implemented as a way of making choices favoring mission related priorities. Such strategies unequivocally mean that less important subjects will receive a reduced priority. These techniques, coupled with evaluation of the current state of collections, consideration of cooperative availability of materials, and budgetary capability should all be combined into a "collection development policy" that meets the needs of the library.

Contemporary subjects included in agricultural collections are discussed at length; it is expected that the subject scope of agriculture will continue to evolve as pure and applied science and technology take on increasing importance in agriculture. As biotechnology and other hybrid fields evolve, new subjects will increasingly need to be acquired for agricultural collections. As information in all subjects increases in volume, diversity of source, and complexity, "core literature" projects, such as that currently being conducted at Cornell, will take on greater importance.

Collection analysis, particularly by use of the RLG conspectus, will become more important for large libraries. As the scope and complexity of agricultural literature increases, libraries will find it necessary to incorporate evaluation into collection development policies.

Cooperative collection development, as practiced by NAL, NLM, and LC for some fields of agriculture, will serve as an example to libraries of all types. Increasingly, with acquisitions funding diminishing, libraries will find it necessary to enter into cooperative collection development agreements on local and regional bases.

Preservation, while seeming to be an ancillary topic, is of concern to all libraries and enters into collection development decision-making. The decision to preserve or withdraw an item rivals the decision to acquire a new item. Since institutions are increasingly reluctant to undertake expensive library construction projects, the issues of space, preservation, and acquisition are all interrelated and must be treated by systematic collection development policies. While many administrators hope for the magic electronic revolution that will replace print collections, the print format will continue to dominate. Nonetheless, a revolution in electronic and optical formats can be expected to influence agricultural library collection development.

While this article gives extensive treatment to selection sources, agricultural bibliographers would be aided by the continued development of guides to the many subject areas. As collections become increasingly converted to electronic formats, creation of customized subject guides to specific collections becomes more feasible. Comparisons of local holding lists to holdings of other major agricultural collections could result in the availability of desiderata files guiding the enhancement of collections.

In conclusion, it can be said that agricultural libraries of all types and missions will find it necessary to undertake formalized collection development. As materials become more expensive, local decisions to acquire will become more critical and responsibility for coverage will increasingly be shared via cooperative agreements. Concomitantly, libraries will adopt automated union lists of books and serials, and make extensive use of bibliographic citation databases, table of contents databases, and full-text electronic formats. Innovative delivery systems will provide material not otherwise available. Overall, conditions of cost, technology, and quantity of information combine to define an era of systematic and cooperative collection development for agricultural libraries.

APPENDIX

Resources

As mentioned previously, suppliers' catalogs or lists can be a rich source for obtaining agricultural materials that are not available through the traditional book trade, such as grey literature or out-of-print titles. Not only are these catalogs valuable selection aids for staff, but they provide important contacts for acquisitions librarians. A resource file of these specialized agencies and/or book dealers can be useful not only in acquiring materials more efficiently, but also in providing sources of information about availability of publications. The following is a selected list of sources:

GENERAL SUPPLIERS

Academic Book Center
5600 NE Hassalo
Portland, OR 97213
(Currently market testing as a supplier of audiovisual materials.)

AgriBookstore
1611 N. Kent St.
Arlington, VA 22209
(Supplies items listed in its catalog only; requires advance payment.)

agAcess
P.O. Box 2008
Davis, CA 95617
(Supplies current agricultural and horticultural books. Also has an out-of-print service.)

Agriculture Canada
Sir John Carling Bldg.
930 Carling Avenue
Ottawa, ON K1A OCS
Canada

CAB International
Farnham House
Farnham Royal
Slough, SL2 3BN,
England

Centro International de Agricultura Tropical (CIAT)
Apartado Aereo 6713
Cali, Columbia

FAO Documentation Centre
Food and Agriculture Organization of the United Nations
Via delle Terme di Caracalla
00100 Rome, Italy

InterDok
173 Halstead Avenue
Harrison, NY 10528
(Publishers of the *Directory of Published Proceedings*, they supply proceedings included in the directory as well as others.)

FAO Liaison Office
1001 22nd St. N.W.
Washington, D.C. 20437

International Rice Research Institute (IRRI)
P.O. Box 933
Manila, Phillippines

Spaulding Company
Graphic Microfilm Division
80 Hawes Way
Stoughton, MA 02072
(Supplies land-grant agricultural publications on microfilm.)

UNIPUB
4611-F Assembly Drive
Lanham, MD 20706-4391
(U.S. and Canadian distributor of FAO sale publications.)

SUPPLIERS BY COUNTRY OR REGION

India

Asia Books & Periodicals
Prints House
11/3 Darya Ganj
Ansari Road
New Delhi-110002, INDIA

D. K. Agencies
Regional Office, 12 Bali Nagar
New Delhi-110015, INDIA

New Zealand

New Zealand Export Books
P.O. Box 14054
Hamilton, New Zealand

APPENDIX *(Cont.)*

Australia

James Bennett Library Services
4 Collaroy St.
Collaroy, NSW 2097, AUSTRALIA

Soviet Union

Otto Harrassowitz
Taunusstrasse 5
6200 Wiesbaden, GERMANY

Latin America

Libros Latinos
P.O. Box 1103
Redlands, CA 92373

Victor Kamkin
12224 Parklawn Dr.
Rockville, MD 20852

Scripta
720 Cayuga St.
Lewiston, NY 14092

Spain

Puvill

Boters, 10 y Paja, 29
08002 Barcelona, SPAIN

APPROVAL VENDORS

African Imprint Library Services
Box 563
75 King Street
Falmouth, MA 02541
(coverage: Africa)

B. H. Blackwell LTD
Borad Street
Oxford OS1 3BQ
ENGLAND
(coverage: United Kingdom)

Coutts Library Services, Inc.
736 Cayuga Street
Lewiston, NY 14092
(coverage: North America)

Puvil Libros, S.A.
Boters, 10 y Paja, 29
08002 Barcelona
SPAIN
(coverage: Spain)

Scholarly Book Center
451 Greenwich Street
New York, NY 10013
(coverage: North America)

Baker & Taylor
Midwestern Division
501 S. Gladiolus Street
Momence, IL 60954
(coverage: North America)

Blackwell North America, Inc.
1001 Fries Mill Rd.
Blackwood, NJ 08012
(coverage: North America)

Otto Harrassowitz
Taunusstrasse 5
6200 Wiesbaden, GERMANY
(coverage: Europe; other areas by negotiation)

Puvill Mexico Division
Entressa 109
Col. Mixcoac
Mexico DF 03910, MEXICO
(coverage: Mexico)

Yankee Book Peddler
Maple Street
Contoocook, NH 03229
(coverage: North America)

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Computers and Communication: Technologies for the Management of International Agricultural Information

ELEANOR FRIERSON AND GEORG LINDSEY

ABSTRACT

BEGINNING WITH THE HISTORICAL basis of today's scientific information explosion, this article examines the changing paradigm of information retrieval. The shift from the point of view of the codifiers of information to that of the end users is brought into focus. Four key technologies are examined: telecommunications, optical media, data conversion technologies, and expert systems. Each is described technically and evaluated for its importance and potential applications. The conclusions highlight the ways in which libraries and information resource centers can employ these new technologies to increase their ability to respond to users and to the scientific community as a whole.

INTRODUCTION

> It is more of a job to interpret the interpretations than to interpret the things, and there are more books about books than about any other subject. (de Montaigne, 1595, p. 13)

For hundreds of years, complaints have been voiced about the need for handling the information overload. And for almost as long, solutions have been put forth to solve the problems. Each solution brings its own set of new problems. Information technologies, such as the printing press, the photocopier, and, to some extent, the computer, have added to, rather than relieved, this knowledge glut. Witness for example the extent to which computers have brought about the "paperless office." In fact, their introduction into offices has dramatically increased the amount of paper used.

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In the 1990s a different set of potential solutions will emerge. Newer and better low-cost technologies will offer alternative methods for dealing with information. Managers of information service programs will be concerned with *how* to automate rather than *whether* to automate. Even small information centers will be able to contain and manage massive amounts of information. Optical storage media like CD-ROM (Compact Disc-Read Only Memory) will allow even the smallest information center to offer significant holdings; and data conversion technologies will offer cost-effective management of highly specialized and/or unpublished literature—literature which might otherwise go uncataloged or be relegated to storage.

Optical storage media can contain huge amounts of information in a tiny space. To find any of this information is rather like trying to find a needle in a haystack. Just as a library is more than a warehouse for books, a CD-ROM must contain more than raw information. A data structure must be created and supported in software to organize the data. Procedures must be provided to deal with updates to the information. And, ideally, assistance should be available to the user to answer questions about the information and to help when searching through it. Unlike a physical library, a CD-ROM by itself contains no visual cues or physical organization to help a naïve user.

In themselves, optical media create as many potential problems as they do solutions. At the moment, however, there is great hope. Developments in software and telecommunication technologies offer the missing links that the optical technologies require to be effective. Hardware and software components in development right now could be the major information innovation of the twentieth century. They could, in fact, be the most important advance in information technology since the introduction of the printing press.

Hardware and software alone cannot produce major breakthroughs in the management of information. Changes in procedures, methods, and techniques are required as well. An important aspect of the changes that are occurring in the science of information management is the transfer of control and responsibility to the end users. This transfer of power is not unlike the transfer which occurred when users switched from large centralized computers to personal computers.

Approach

The observations presented in this article are based on technologies in use or under development at International Agricultural Research Centers (IARCs), the National Agricultural Library (NAL), CAB International (CABI), the World Bank, and in particular the centers of the Consultative Group on International Agricultural Research (CGIAR). CGIAR is an international consortium sponsored by the Food and Agriculture Organization [FAO] of the United Nations, the World Bank, and the United Nations Development Programme [UNDP]. Its mandate is to support research programs aimed at improving the quantity and quality of food production in developing nations. These programs are carried out by thirteen autonomous international agricultural research centers located in Colombia, Ethiopia, India, Italy, Ivory Coast, Kenya, Mexico, the Netherlands, Nigeria, Peru, the Philippines, Syria, and the United States. Each center, in turn, has experimental stations and regional offices totaling over 100 remote sites in over 60 countries.

Based on the activities of these institutions, four key technologies have been identified as particularly important. Four is certainly no magic number, but this group will serve as a useful continuum for discussing the "here and now" to the more distant future. The first key technology is telecommunication, a technology which is certainly growing rapidly, but which is readily available and widely used. The second is optical media including CD-ROM. The value of optical media technology has been proven, many applications have been identified, and high rates of growth in its use are expected. Data conversion technologies are the third key area of discussion. Major experiments and demonstration projects are underway. The fourth area of discussion is expert systems and artificial intelligence. These hold great promise but are still mainly in the laboratory and are the subject of primarily academic experimentation.

For each of the technologies discussed—telecommunication, optical media, data conversion technologies, and expert systems—this article includes a brief technical description of "how it works," an explanation of its importance, a description of the applications for which the technology is suited, and real-world examples of its use in agricultural applications. When appropriate, "lessons learned" are discussed. The content of the article is keyed to the current state of development of each technology. For telecommunication and optical media, the material presented is more detailed and contains specific "how to" information. For data conversion technologies, an area with no standards and few agreed upon formats, the discussion is more general. For expert systems, the descriptions reflect the state of the art and are largely academic.

This article also briefly examines the historical basis of the information explosion. The changing paradigm—moving from dealing with information from the codifiers' point of view to the end users' point of view—is explored.

The article concludes with recommendations of how libraries and information resource centers can exploit the new technologies to increase responsiveness to users and to the scientific community.

BACKGROUND

Concerns for the handling of information have been heard since the beginning of the scientific revolution. The seventeenth century witnessed the rise of scientific societies and publications for "monitoring and digesting the learned publications that were too much for one man to cope with" (Price, 1963, p. 15). Sir Humphrey Davy was throwing away his books in the eighteenth century because no man could ever have time to read the same book twice. The nineteenth century saw the rise of specialized journals and abstracts. The twentieth century followed the general theme of information overload, but important developments began to occur around the time of World War II .

In 1938 H. G. Wells wrote *World Brain* in which he outlined a plan for a "World Encyclopedia":

> A row of volumes in his own home (in which the average citizen would) without any great toil or difficulty, find in clear understandable language, and be kept up to date, the ruling concepts of our social order, the outlines and main particulars in all fields of knowledge, an exact and detailed picture of our universe, a general history of the world....And next let us take this World Encyclopedia from the point of view of the specialist....To him even more than to the common intelligent man World Encyclopedia is going to be of value because it is going to afford him an intelligible statement of what is being done by workers parallel with himself. (pp. 19, 24)

Wells's plan reflected the view that to utilize information one must codify and store it. In 1945, Vannevar Bush presented an article which emphasized the need for better means of access to information:

> There is a growing mountain of research, but there is increased evidence that we are being bogged down today as specialization extends. The investigator is staggered by the findings and conclusions which he cannot find time to grasp, much less to remember as they appear...the means we use for threading through the consequent maze to the momentarily important item is the same as it was in the days of the square-rigged ships. (p. 101)

Bush anticipated the needs of scientists in dealing with information overload and proposed that computer systems be developed which would be tailored to the needs of users. Soon after the publication of Bush's article, studies of information use began to appear in the documentation literature. Since then, several thousand studies have been undertaken and comprehensive reviews of these can be found in such sources as Shaw (1956), Taube (1959), Menzel (1960), Crawford (1978), Lindsey (1979), and others.

The literature of user behavior and the use of information systems strongly support the following point: the end user perspective is critical in managing the impact of the new technologies. The technologies which can finally provide the solution to Bush's posed problem are at hand and are ready for application.

Telecommunication and the Flow of Agricultural Communication

Agricultural research cannot function without extensive use of communication. Rapid, reliable, and economical communication in the form of electronic mail and data transfer is in place at most of the IARCs via a data communication facility which has come to be called the CGNET. (The term CGNET was originally used as the name of the electronic mail facility which interconnects members of the CGIAR. The CGNET is now a private organization which connects fifty international institutions in forty-five countries.) This network began as a feasibility study funded by the International Development Research Centre (IDRC) in 1983. It has evolved to become a self-sustaining, operational network. Centers currently transfer messages, documents, data, and computer files throughout the world. At the same time, the system saves its members about $1 million per year. These savings are accomplished by displacing more costly technologies such as telex, telefacsimile, and courier. A telex or telefacsimile can cost twenty-five times as much as an electronic message.

The CGNET is not primarily a physical network, although the links to some centers have required special attention when good communication cannot be maintained using conventional methods. For example, the International Institute for Tropical Agriculture (IITA) in Ibadan, Nigeria, installed a digital microwave link and leased telephone lines to provide a reliable connection to the international communication system. IITA is currently evaluating satellite earth stations. The International Rice Research Institute (IRRI) in Los Banos, Philippines, has established a digital microwave link to Manila which dramatically improves voice and data capability. A satellite earth station is currently being used at the International Irrigation Management Institute (IIMI) in Sri Lanka. In general, however, CGNET relies on network facilities provided by international record carriers, domestic data network services, and facilities of a particular country's Public Switched Telephone Network (PSTN). The electronic services are provided by computers in the United States, in the United Kingdom, and Canada. When inbound access to center computers is available, the international centers are able to provide additional services directly from their locations. The Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT) in Mexico has already established such international access, and its computers are used daily from the United States and Peru. IRRI's computer is expected to be internationally accessible in 1990.

Worldwide, several additional networks provide linkages to over 2,000 information centers and universities. Notable examples include BITNET (United States), EARN (Europe), NETNORTH (Canada), and JUNET (Japan). A complete description, including technical details and addressing protocols of these and some twenty additional networks, can be found in Quarterman and Hoskins (1986).

Electronic Mail and Computer-Based Messaging Systems

Computer-based messaging systems (CBMS) began as simple programs used to exchange short messages. The messages were typically between users who were sharing the same central computer system. As computer networks became more prevalent in the late 1960s and 1970s, these message systems were expanded to allow users of different computers to send messages to one another. This was accomplished by designating one computer as a "depot" for messages and giving each user a collection of files, or "mailbox," on the depot computer. Any user could deposit messages in the mailbox of any other user, and all users were obligated to remove messages from their own mailboxes. With time, the programs were refined to inform users when mail was ready for pick-up, and to provide many other information services. Eventually these CBMS mailbox systems came to be called electronic mail, or e-mail systems.

Electronic mail facilities usually consist of large-scale computers accessed either through local data networks or through direct telephone dial-in. As a result, countries without a local data network may, through a telephone line and modem, connect to the electronic mail computers in another country and participate in sending and receiving mail.

When individuals "log on" to an account—i.e., provide a valid account name and security code—they are automatically informed as to whether they have received any mail. They can then request to read mail, to send mail to other users, to forward messages, and/or to reply to messages. Users have numerous options available, including sending messages to a single user or to many users at once; sending a message to a predesignated list of users; requesting an automatic acknowledgment when the recipient has read the mail; sending a message as a telegram; and sending a message to a telex or telefacsimile machine. These last options are important because they allow communication to others who do not have access to the electronic mail service. Electronic mail users can also access a number of database services including airline schedules, news wire services, and agricultural forecasts.

The equipment used to access electronic mail services usually consists of a microcomputer, a communication software package, and a modem. The modem provides the connection between the telephone line and the computer, and the communication software allows the computer to interact with the modem. Access is also possible directly from an organization's mainframe computers, as is done at CIMMYT, the World Bank, and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India.

The Value of CBMS

Since electronic mail makes more efficient use of communication media than do conventional services such as telex, use of electronic mail can generate significant cost savings. Of course the cost of the service depends on how much it is used; but most users realize a significant reduction in total cost.

Electronic mail can also improve the quality of communications. Since electronic mail is less expensive than conventional services, users tend to explain themselves more fully and correspond more frequently.

Many matters that might have been discussed only in a letter, or not at all, can be reviewed economically in an electronic mail message. The benefits of this faster and more frequent communication cannot be easily translated into specific monetary amounts. The ability to make better and more timely decisions, for example, can be profoundly important yet difficult to quantify. The effect of more frequent contact on the morale of staff working in a remote location is also important but hard to measure.

Electronic mail provides other benefits as well. As opposed to telex, documents arrive in machine-readable form so they can be immediately used on local word processing equipment. Documents that have already been entered on a computer or word processor can be immediately transferred via the network without rekeying. The lower cost allows documents that normally would be sent by mail or courier to be sent instantly and economically. Many centers find that there are a few reports or proposals every year for which such instant transfer is invaluable.

Technological Improvements in CBMS

Data communication—the movement of information between computers—is the technology behind the growth of CBMS. It is an extremely dynamic field, and one that is the focus of investment programs in many countries. Some of the important developments that are on the horizon are discussed later.

Internetworking and X.400. Many organizations run internal CBMS services to provide internal electronic messaging and data sharing. For example, ICRISAT and CIMMYT use minicomputers to collect and instantly distribute intracampus mail, and the World Bank runs several different message services to connect its many employees. A natural improvement to such facilities is to tie the CGNET and these internal networks together so that mail can flow automatically from the personal computer of, say, a soil scientist in Hyderabad, India, to the personal computer of a counterpart in another center or in a university. These desk-to-desk transfers make possible a much quicker and more immediate kind of communication than is possible when messages go through a message office.

ICRISAT and CIMMYT have developed special purpose programs that accomplish this link to the CGNET. The World Bank uses commercially purchased programs to make the link. In the last few years, the CCITT (Consultative Committee for International Telegraph and Telephone) has developed a world standard for internetworking, called "X.400." X.400 programs are now available so that a wide variety of computers and networks can link directly to the CGNET. It is expected that these X.400 links will be especially important as personal computers are linked into local area networks.

Improved International Access. In all the industrialized countries and many developing ones, the CGNET (and other computer services) can be reached with a telephone call and an account with a local telecommunications company. This type of international data network is expanding. In the last three years, many countries in Latin America and Southeast Asia have established data network access. Recently, Egypt and India have formed such a service; in the next two or three years several countries in Africa also will offer it. Of the countries that have established these services, many have reduced their rates (e.g., some network providers in the Philippines cut their rates last year by 50 percent). Meanwhile, the existing data network locations have been improved. Some now have facilities that allow billing of the communications costs from different international access points directly to a user's home account. The user is not required to a have a local account in each of the international locations. This arrangement is ideal for travelers. It is also helpful for new CGNET users and for users who need a backup facility. Sometimes it is less costly to use the U.S. home account for billing rather than use the facilities of a particular country.

Better Modems. For those without a local data network, an intercontinental telephone call is required to connect to the network. The quality of this connection can be a problem, but there are now alternatives which can overcome these technical difficulties. This has become easier in recent years with the introduction of higher speed, error-correcting modems, and recently introduced modems and operating standards promise even higher speeds and better immunity to line noise.

Direct Satellite Links, and Packet Radio. These unconventional technologies allow connections to be made by radio in locations that do not have a telephone. Packet radio systems add special circuitry to ordinary two-way radios to allow the reliable transfer of computer data. They are inexpensive but can be difficult to operate. Satellite-based systems are easier to use and work over greater distances but are more expensive. Both of these technologies are limited at present by restrictive government regulations in many countries. Eventually, they can be expected to play an important role in filling gaps in conventional telephone networks.

New Services. Recently, it has become possible for network users to send messages by telefacsimile from their accounts, much as they already can send electronic mail and telexes. For many users, this allows communication to more off-network locations, usually at a lower cost than if an ordinary telefacsimile machine was used. This has been especially valuable for locations that do not have the funds or the telephone lines that would be necessary for installation of an ordinary telefacsimile machine.

As technology progresses, information centers and libraries will continue to see improvements in CBMS service offerings. Judging from past experience, they can be expected to adopt these improvements incrementally as appropriate to their needs and abilities to absorb the new technology.

Managing Data with Optical Storage Technologies

Over the last five years, the advent of optical storage technologies has quickly changed perceptions of how much and what kinds of data can be made available at reasonable cost on a distributed basis. Optical storage technologies can be used in association with individual or networked personal computers as well as larger computers. Development of the physical storage medium itself appears to be more advanced than developments of techniques for data conversion and for software to support the physical media.

Technical Description of Optical Storage Technology

Optical storage technology is also sometimes called laser storage technology because lasers are used to encode data onto a photosensitive disc surface. The three most common techniques used to record data are bubble-forming, phase-changing, and pitting. Bubble-forming is used only with Write Once Read Many (WORM) technology; the laser heats the physical storage medium, causing a bubble to form. In phase-changing the laser heats the medium and thereby changes its reflectivity.

In pitting, the laser burns holes or pits in the medium. The pits represent information in electronic form. On the most commonly used medium, optical discs, data are stored in tracks that are laid out either in one continuous spiral or in concentric circles separated into sectors. Data are read off such discs with a disc reader which shines a laser onto the disc. The disc reflects light and the reader interprets the different patterns of reflection from the pits and spaces between pits (called lands).

Data can be recorded on optical storage media in either analog or digital formats, so named because analog or digital signals are used to transmit the data. An analog signal resembles a wave. It is a continuous signal, commonly used for television transmission. A digital format stores information in the same on/off electrical pulses used for computers. For computer handling, analog data must be converted into a digital format. Analog storage is used most often for motion pictures and other graphic information. Digital storage is most often used for data, scanned images, and text. Both analog and digital data can be stored on some types of optical storage media.

Optical storage media are of great interest because of the following advantages over other types of storage media:

1. They provide very high-density storage. For example, one 12 inch optical disc can store the equivalent of 5,000-10,000 microfiche;

200,000-400,000 pages of text; 25,000-50,000 pictures; or 40 reels of magnetic computer tape.

2. Some types are very inexpensive to reproduce. For example, Compact Disc-Read Only Memory (CD-ROM) discs can be reproduced in large quantities for as little as $2 per disc.
3. Some types, such as CD-ROM, are extremely durable.
4. All are impervious to disturbances caused by electromagnetic fields.
5. Most are easily portable.
6. They can be easily connected to personal computers.

There are three categories of optical storage media:

1. *Read Only Memory (ROM).* These discs cannot be altered once they are manufactured. The data set is transferred from the user's original medium (usually a hard disc) onto a nine track tape. The tape is then sent to a mastering plant where the data are transferred onto a glass master disc using lasers. Finally, durable read only compact discs are replicated from the glass master at a low per unit cost.
2. *Write-Once-Read-Many (WORM).* Data are recorded to the media directly by the end user at a workstation. The data cannot be changed or erased after recording, but data can be added until the disc is full. Large organizations use WORM media to distribute large data sets.
3. *Erasable media, also sometimes called write-many media.* Erasable discs, erasable storage cartridges, and digital paper or "paper tape" are very new products and should still be considered experimental. Erasable media are similar to WORM media in that they are also produced at the user's workstation. However, they can be changed after data are recorded.

Within these three categories, new types of media are constantly being developed. Some major types of available optical storage media are digital videodiscs (also called laserdiscs or laser videodiscs), Compact Disc-Audio (CD-Audio), CD-ROM, WORM discs, WORM cartridges, and lasercards (also called optical cards). An excellent analysis by Eaton, MacDonald, and Saule (1989) describes these newer media in some detail. This article focuses on CD-ROM, WORM, and digital videodisc as the optical technologies most likely to be of interest to information services providers in the near future.

CD-ROM Technology

CD-ROM technology has revolutionized the provision of data to libraries and end users (Paisley, 1989). It is the only commonly available optical storage medium for which there are standards for disc and hardware production. Producers and publishers of all kinds of information have been challenged by a rapidly increasing market. Tremendous economies of scale are possible. Because the technology is based on that used to produce musical compact discs, a very popular technology, acceptance has been easier than for more unfamiliar optical storage media.

CD-ROM discs are currently used mainly for access to databases, full-text materials, and images. However, as proposed standards are accepted, multimedia discs will be developed that combine data, audio, and graphic materials into exciting products that can now only be imagined.

At present, CD-ROM is most useful when applications meet the following criteria:

1. The overriding requirement is data dissemination.
2. The data set is in digital form.
3. The data set is stable and updates can be periodic.
4. The budget available for information dissemination is limited.
5. The equipment available to end users is based on standard personal computers.

Agricultural Applications of CD-ROM Technology

The agricultural sector has pioneered a number of CD-ROM applications. In particular, agricultural institutions are playing a leading role in the use of CD-ROM for information dissemination in developing countries where there are large information gaps because of limited access to externally produced information. NAL, CAB International, the Technical Centre for Agricultural and Rural Cooperation (CTA) in the Netherlands, and the CGIAR centers and secretariat are among the institutions that have produced or sponsored important CD-ROM projects (Dellere, 1987; Kinney, 1986; Technical Centre for Agricultural and Rural Cooperation, 1987; Treitz, 1987).

The NAL AGRICOLA database was one of the first to be commercially available on CD-ROM. Two AGRICOLA products, produced by SilverPlatter Information, Inc. and OCLC (Online Computer Library Center, Inc.), are available worldwide. Because AGRICOLA tapes are relatively inexpensive as U.S. government public domain information, more AGRICOLA CD-ROM products are also being developed. Quanta Press will release an AGRICOLA product in Fall-Winter 1990.

In addition to the AGRICOLA CD-ROMs, NAL has taken a leadership role in the exploration of CD-ROM use for the preservation and dissemination of full-text and image documents. The National Agricultural Text Digitizing Project (NATDP), as described by André, et al. (1989), is a major cooperative project of forty-six U.S. land-grant universities and NAL. It is testing solutions for conversion of full-text and image data, search software, and telecommunications transfer of data from CD-ROMs.

Dextre Clarke (1989) described one of the earliest agricultural CD-ROM experiments by CAB International. A sample of the *CABI Abstracts* database was put onto a CD-ROM and evaluated in a diverse set of international locations. It was a pioneering effort to provide access to essential agricultural information in developing countries and has produced important evaluation data for those interested in similar work. Users expressed enthusiasm even though the MicroBasis software was very slow.

Within the CGIAR, the Centro Internacional de Majoramiento de Maize y Trigo (CIMMYT) in Mexico, also known as the International Maize and Wheat Improvement Center, produced a pioneering CD-ROM for plant breeders. It contains CIMMYT's maize germplasm database and is intended for scientists as well as information centers.

Both the CABI and CIMMYT projects were implemented with partial funding from CTA. CTA is now funding a pilot project to provide CD-ROM workstations and a collection of agricultural CD-ROMs in eleven developing countries ("CTA and KIT Cooperate," 1989).

The CGIAR secretariat has been working on its CGIAR Preservation and Dissemination Project since 1986. Funded by the World Bank, IDRC, the United Nations Development Programme (UNDP), the Rockefeller Foundation, and the governments of Italy and the United Kingdom, this project seeks to establish a continuing program for publication on CD-ROM of the major literature produced by twenty IARCs. Aspen Systems Corporation (1987) and Frierson (1987) provide technical details on the project. A prototype disc, *Food, Agriculture, and Science,* has been produced and is being evaluated through the NATDP in the United States and through the secretariat in about forty sites outside the United States.

CABI, the Food and Agriculture Organization of the United Nations (FAO), NAL, the Royal Tropical Institute, the French government, the International Food Information Service (IFIS), the CGIAR secretariat, and others interested in the production of CD-ROM products for agriculture have formed a working group on CD-ROM. The group has been meeting since 1988 to exchange information on projects and has worked to standardize training, equipment, and other aspects of CD-ROM production to minimize confusion for end users and to reduce duplication of effort.

So far most of the CD-ROM work in agriculture has been led by libraries and other information services providers putting bibliographic and similar databases on CD-ROM. There is great potential for production and distribution of CD-ROMs containing other types of specialized agricultural databases such as: germplasm information, crop protection and quarantine data, directories, economic and statistical data, geographic and agro-ecological information, and administrative information.

WORM Storage Media

Write-Once-Read-Many (WORM) technology allows a user at a workstation to store up to 800 megabytes of data onto a 5.25 inch cartridge. Most manufacturers, including DEC, Sony, and Laserdrive, use the method of having the WORM drive emulate a standard hard disk drive through software. This allows the user to utilize ordinary software to store data on the drive. Access speeds for WORM drives are 150-250 milliseconds. These speeds fall between those of typical hard disk drives (15-40 milliseconds) and CD-ROM drives (350-750 milliseconds). WORM drives are reliable (typical rating of one uncorrectable error per every 1 trillion bits of information) and durable. Sony rates the media life expectancy of their WORM drive at 100 years.

WORM media are most appropriate for applications meeting the following criteria:

1. When the number of copies to be distributed is limited.
2. When data need fairly frequent updating.
3. When nonstandard or proprietary equipment is available for end-users.

Because WORM media can be produced locally and data continuously added, they are very useful for localized projects. However, since there is little standardization of equipment, discs, or cartridges, information producers must be careful when using WORM technology to make sure that data needed for the long term can be transferred from the WORM medium if a better or more standard technology appears. Producers also must be aware that WORM discs and cartridges have failed, and that a backup facility always should be part of a WORM-based system.

WORM technology currently is used for data preparation and premastering for CD-ROMs. It is expected that such use will continue and that WORM technology will be used to fill the gap between centralized large computer systems and small groups of users who need current information but cannot be connected to the central computer. For example, major computer equipment manufacturers such as IBM, Wang, and Philips are developing WORM-based systems for records management and archival applications. Until facilities for mastering and copying CD-ROM discs are more widespread and CD-ROM production cycle delays are reduced, WORM technology is more appropriate for such situations.

Digital Videodisc

Digital videodiscs, also called laserdiscs or laser videodiscs, can hold much more information than CD-ROMs and are being used for multimedia applications, particularly for education and training. As with WORM technology, there is no current standardization of disc format or equipment, and discs cannot be interchanged among different equipment. If the proposed Compact Disc-Interactive (CD-I) or CD-ROM Digital Video Interactive (CD-ROM DVI) standards are developed and accepted by manufacturers, CD-ROM may replace digital videodiscs for which no standardization appears imminent.

The NAL has also pioneered the use of digital videodiscs. In addition to its production of the Pork Industry Handbook disc (André

1985, 1986), NAL has recently produced a very effective interactive training tool for AGRICOLA searchers called AGRICOLearn (see National Agricultural Library, 1988).

Data Conversion Technology

Computers have become smaller, more portable, and much faster. With these technological advances have come increasing demands for access to large amounts of data that could not be handled by older machines. In libraries and information centers, most of these data are still available only as printed information. The challenge now is to convert printed information into electronic data.

In agriculture, materials that could be useful in electronic form include handwritten journals of botanists and scientists, drawings, photographs, slides, maps, statistical data, and printed publications in various languages and alphabets. Access to information contained in these materials has traditionally been through secondary methods such as indexes, abstracts, and catalog records. Having access to the full text has been difficult because manual data entry and human editing were too expensive and time consuming.

Now scanning technology offers intriguing possibilities for machine conversion of this information into electronic forms suitable for searching, retrieval, and manipulation. Scanners are currently sold for prices ranging from a few hundred dollars to several hundred thousand dollars.

Scanners are available for accurate conversion of black and white and color images, at varying levels of resolution, for a full range of prices. Several are reasonably priced and perform at acceptable levels of speed. Reasonably priced color printers are also coming onto the market. However, despite vendor claims to the contrary, very few text scanners can achieve 100 percent accuracy at a reasonable rate of speed unless the original text is in one language, printed clearly, and in a fairly simple format without fuzzy characters, letters touching one another, subscripts, superscripts, formulas, and other difficult to convert characters. Tabular data are a particular challenge. To achieve perfectly accurate electronic text data, data created by scanning must normally be revised and edited. Revision and editing times and costs may be so high that keying would be less expensive and time consuming.

The NAL sponsored a conference on the application of scanning methodologies in libraries in late 1988. Summarizing the experiences reported by speakers, Hayes (1989) concluded that if scanning produced lower than 95 percent accuracy, keying would be less expensive and faster. Hayes also reported that, with the possible exception of proprietary techniques used by Optiram, Inc. in the United Kingdom, there was no interactive system that effectively interfaced scanning with the decision processes that were required to undertake the scanning task. André, et al. (1989), reporting on the National Agricultural Text Digitizing

Project, provided specific information on the challenges of text digitization. Cahan (1989) also analyzes the wide variety of available scanners, providing comparisons of speed, price, and performance.

Conversion costs and the potential uses of converted materials should help determine how materials should be converted and stored. There are three types of conversions that have been used in the last few years for agricultural materials:

1. printed or handwritten alphanumeric data into ASCII (American Standard Code for Information Interchange) data;
2. printed or handwritten alphanumeric data into databases with fixed fields or into ASCII data with special delimiters or "tags"; and
3. printed or handwritten alphanumeric data and printed or hand drawn images into bit-mapped images.

Each type of conversion has special requirements, and in many conversion projects all of these options are possible. For each option, this article identifies current agricultural projects from which important lessons are being learned about choices, methods, costs, and uses of "newly electronic" data.

Conversion of Alphanumeric Data

For this discussion, alphanumeric data will include data recorded as numbers and letters in text and tables but not as integral parts of graphics such as photographs and charts. Of the formats developed for recording alphanumeric characters electronically, the ASCII format is by far the most common. In this article it is assumed that the ASCII format is the one that most libraries, information services, and end users will want to use.

While a few high-end scanners currently are able to convert good quality printed text into ASCII files with acceptable accuracy, it will be two or three years before scanners that can handle more complex materials will be on the market at reasonable prices. During this period, keying will be less expensive than scanning and editing. This is particularly true when the data are sent to countries where labor is available at a low cost—e.g., India, the Philippines, and some Caribbean countries.

Since the end product of this first type of conversion is a continuous file with no special coding or tagging to differentiate data elements, the data may be difficult to use in certain ways. For example, in converting printed publications with elaborate page layouts (including such features as different type fonts, multiple columns, and artistic spacing) an undifferentiated ASCII file may not be adequate for display or printing purposes. If this is the case, then the next type of conversion should be considered.

Conversion of Alphanumeric Data into Fielded or Tagged ASCII Data

If the situation is not conducive to converting full-text information into ASCII files by electronic means, then converting the same kind of information into tagged or fielded ASCII data is virtually impossible. However, in some cases, tags or fields are a necessity. Some reasons are:

1. to label or delimit particular types of full-text information. It may be useful to know where the title page begins, where chapter headings are, or that a particular string of characters represents the caption of a photograph;
2. to make tabular data useful. It may be useful to separate a table heading, footnote, or caption from the data; and
3. to recreate the "look and feel" of the printed text on screen or through reprinting. If ASCII data are not fielded or tagged, a carefully laid out publication may become an undifferentiated text file. It may be important to preserve artistic and editorial decisions for better presentation of the information.

Weibel, et al. (1989) illustrate some of the challenges inherent in using scanning to convert printed materials into tagged databases. They also discuss the Standard Generalized Markup Language (SGML), a standard for marking up materials for electronic publishing. SGML codes can be useful when it is desirable to display or print text to resemble a printed version. However, scanners that can read in printed pages and convert them into ASCII text encoded with SGML descriptors are neither widespread nor priced at a level that will permit large-scale purchases.

Conversion of Alphanumeric Data and Printed or Hand-Drawn Images Into Bit-Mapped Images

Bit-mapped images are electronic pictures of data that are produced by scanners which identify patterns and shades of color. Once scanned, bit-mapped images can be edited to remove imperfections present in the original, and, when printed, can produce a clearer copy than the source material. However, the content of bit-mapped images cannot be searched. Additional identifying information must be added to scanned images so they may be retrieved. The information can refer to a set of images (e.g., an entire publication) or to each separate image to be stored (e.g., every photograph in a collection or every figure in a book).

Stored images also require much more storage space than ASCII text. How much storage is required depends on the density of the original image, whether color preservation is required, the level of resolution at which images are scanned, how much grey scale is present, whether the converted images are compressed before storage, and which of several image storage formats is used. Other factors also affect storage requirements. Walker (1989) provides an excellent summary of issues involved in converting documents into bit-mapped images.

A major difference between image conversion and alphanumeric data conversion is that, while there is a common format for alphanumeric data (the ASCII format), there are several formats used for the storage of electronic image data. In addition to proprietary formats which can be manipulated and stored only with particular equipment and software, there are more universal formats such as the international standards of the Consultative Committee on the International Telegraph and Telephone (CCITT). CCITT Group 3 and Group 4 standards are encoding formats created for telefacsimile transmissions. These standards involve digital data compression and are generally implemented in telefacsimile machine hardware. TIFF (Tag Image File Format) is another family of formats commonly used for digital image files on microcomputers. Header information in the file identifies the data encoding and compression scheme used for the image.

Adoption of a standard format would be of benefit to producers and users of optical media, but, as is usually the case before standardization of a technology, there are opposing viewpoints about which format will provide the best standard. One benefit of the CCITT standard would be the ability to utilize existing telecommunication facilities and equipment for the transmission of images.

Photographs and other graphics must be stored as scanned images. In some cases, it is beneficial to store alphanumeric information also as images. Reasons to do this may include:

1. the conversion of pages of alphanumeric data into bit-mapped images can be much less expensive than conversion into ASCII characters.
2. A non-Roman character set (Arabic, Japanese, Chinese) may not be useful in ASCII or represented in ASCII.
3. It may be important to preserve a precise replica of printed or handwritten information for legal reasons or because the source document cannot be preserved any other way.
4. The publisher or copyright holder of the material may not grant permission to provide access to an ASCII version.
5. Tables may be too wide or too complex to convert and display with available software or equipment.

Considering and choosing among options for converting data can be a complex task. The cost of conversion into a standard image format or SGML coded text file, for example, can be high. However, unless it can be anticipated that the data will always and only be used in the same system, the best conversion investment will be one that converts information into a standard format that will allow data to be stored and transferred among many information systems.

The advent of optical storage technologies has very quickly changed perceptions of how much and what kinds of data can be made available at reasonable cost to end users with personal computers and through storage devices in a network environment. Development of the storage technology has raced ahead of the software and data conversion technology. Standards for data creation and transfer have become very important, not just for bibliographic data—the traditional product of libraries and information services—but also for numeric and image data. While scanning technologies offer some hope, data conversion is still quite expensive.

Expert Systems

An outgrowth of artificial intelligence research, expert systems have begun to find commercial application in a few industries in recent years. Expert systems are computer programs that attempt to model the mental processes of an expert. They were originally developed as part of artificial intelligence (AI) research in the late 1970s and early 1980s. AI researchers soon moved on to more difficult problems, but they left behind tools for programming solutions to difficult real life problems. While still promoted as a type of AI, expert systems also can be viewed as simply another type of programming technology, addressing problems that were nearly intractable in other programming systems.

References to expert systems in use at libraries are few. Hanfman (1989) describes AquaRef, an expert advisory system for reference support in aquaculture. Waters (1986) presents Answerman, an expert system for retrieval of information from library reference books. Expert systems in reference services are described by Roysdon and White (1989). Within the general field of agriculture, expert systems have been developed in many content areas. Notable examples include apple orchard management (Roach, et al., 1988) and tractor repair (Gaultney et al., 1989).

From a practical viewpoint, the main reason for understanding expert systems is heuristic. Information managers and providers need to keep up to date on developments and watch for opportunities. The next discussion presents a brief overview.

A Definition

Expert systems are computer programs that make inferences and draw conclusions from statements supplied by a user. They are programmed to reproduce the reasoning, background facts and assumptions, short-cuts, and rules of thumb that human experts use when solving problems. In fact, most expert systems are programmed in close consultation with one or more human experts, and the program is meant to model them explicitly.

The narrower and simpler the range of problems, the more likely an expert system will be successful in solving them. Some of the earliest expert systems were produced in the field of chemistry. DENDRAL, for example, was created in the 1960s at Stanford University to determine the topological structure of unknown compounds from mass spectral nuclear magnetic resonance data (Waterman, 1986). The input data were as quantitative and definite as possible; the rules of thumb were well known and rather well documented; and little knowledge of the outside world was required to do a proper job.

Since that time, a great deal of progress has been made. Expert systems have been developed and sold commercially for financial analysis, engineering design, and database inquiry. These systems usually converse with the user in ordinary unstructured English and can explain the inferences they make. In the case of analysis and design, the inferences made by the system serve as a check and a "back stop" to the judgments made by the analyst or engineer. For database inquiry systems, inferences can make the database much easier to use. A casual user may not be familiar with the details of a database's contents and organization, but an expert system can readily organize and reason about something as limited and well defined as a database. The expert system can help the user quickly find the most relevant data, both by suggesting restrictions for too broad an inquiry, and helping broaden one which is too narrow. In this case, the expert system is modeling a database or library expert.

Components of an Expert System

As with any new area of science, the expert system has been characterized in many ways. Among the generally agreed-upon components which may be of interest to information center managers are:

1. *Knowledge Base.* This contains facts and rules about particular problem areas called domains. The rules and facts come from a human expert.
2. *Inference Engine.* The knowledge base interacts with an inference engine which processes rules methodically. For example, the inference engine will perform forward chaining—i.e., reasoning from a set of data to a conclusion. Alternatively, it can do backward chaining—i.e., reasoning from a set of hypotheses to see if any sets of data can help prove the hypotheses.
3. *User Interface.* This allows the human operator (user) access to the system through "natural" language. This is an extremely important feature because the user does not have to be a computer expert to work with the system. In addition, the system can ask the user for more information. The *explanation facility* is an important part of the user interface. If the user cannot understand why the system is asking for particular information, he or she can ask why. The user can also ask why the program did not follow particular lines of reasoning in reaching conclusions.

Uses of Expert Systems

Based on the categorization of Hayes-Roth et al. (1983) and Waterman (1986), expert systems can be classified into nine categories:

1. *Interpretation.* Expert systems that perform interpretation use input

data to infer situation descriptions. For example, statistical data from crop trials are interpreted to determine if crops are responding to a particular treatment.

2. *Prediction.* Expert systems that perform prediction infer likely consequences of given actions, such as predicting damage to sorghum crops from some type of pest like the shoot fly. An authentic example of an expert system that does prediction is PLANT/cd (Michalski et al., 1982), which predicts Black Cutworm damage.
3. *Diagnosis.* Expert systems that perform diagnosis use symptoms to infer probable causes of problems. For example, using knowledge about disease symptoms and plant environment, an expert system could be devised to provide consultation on the diagnosis of crop disease.
4. *Design.* Expert systems that produce designs operate by developing configurations of objects based on a set of problem constraints. This type of expert system can be applied to agricultural research to produce, for example, newly designed cultivated varieties of crops that are not only resistant to several pests and diseases but that can also withstand harsh environments. By designing plants with the desired configuration and evaluating them in the context of problem constraints, this could substitute for searches for naturally occurring plants with these properties. A popular area for expert system design is molecular biology.
5. *Planning.* Expert systems that perform planning functions design an entire course of action before proceeding—e.g., creating a plan for a new building or a remote research facility.
6. *Monitoring.* Expert systems that perform monitoring functions compare actual behavior with system behavior. For example, an expert system might monitor environmental conditions in semi-arid areas where water is scarce to determine when to irrigate. An expert system of this type is useful for water management.
7. *Repair.* Expert systems that perform repairs follow a plan to administer some prescribed remedy. An example is an expert system that suggests courses of action to take when a microcomputer is not operating.
8. *Instruction.* Expert systems that perform instruction engage in such tasks, for example, as specialized computer-aided instruction systems.
9. *Control.* Expert systems can perform control functions and adaptively govern overall system behavior. Examples would include expert systems for water management or systems which monitor and regulate growing conditions in greenhouses.

The Value of Expert Systems in Information Center Management

In the short term, expert systems are likely to find use in agriculture in the following roles:

1. *To make data resources more accessible.* With an expert system

interface, databases and bibliographies become easier and faster to use. Resources that might never have been consulted at all can now be used by an individual without waiting for the assistance of someone who knows the data. This becomes especially important as CD-ROMs and other technologies make much more information available.

2. *To support the delegation of work to less senior staff.* In the course of an analysis or an experimental design, a junior staff member may need the help of someone with more experience. He/she may be able to go farther before asking for assistance if an expert system is available. This may be especially useful in statistical analyses where the expert system would act as an artificial "statistician's assistant." This "assistant" could give advice to junior staff (or offer a critique as a double check for more senior staff) that would save time, while also freeing time for the human statistician, who could then concentrate on more difficult problems. The end result would be better quality experimental designs and analyses.
3. *To support training.* Since expert systems explain their reasoning as they go along, they can assist in teaching a line of reasoning. The sheer repetitive effect of seeing the reasoning consistently applied across a number of cases can support a student's ordinary course of training. In this application, the expert system can be thought of as a kind of simulation program—i.e., simulating the behavior of an expert in approaching a problem.
4. *To support national research efforts.* The tools that serve International Agricultural Research Center researchers can also serve the National Agricultural Research System (NARS) researcher. IARC expert systems may require further refinement before being released for general use in the NARS, but the prospect of disseminating expertise in automatic and interactive form is full of promise. This is doubly the case when combined with CD-ROM dissemination of databases. An expert system interface can make the CD-ROM information easier to use and more relevant to a user's needs.

The addition of expert systems to CD-ROM databases deserves special attention. Although most retrieval systems are adequate and produce a manageable data set for the user, an expert systems interface can help derive the subset which is most appropriate to the user's needs. By modeling the knowledge of a world expert in the field, one can reduce the search space in a short time period and in an intelligent manner. For example, the first question asked by a maize germplasm expert system may be "At what altitude would you like to grow your maize?" Suppose the user answers 500 meters. The retrieval system, which knows that growing conditions do not vary significantly between a range of perhaps 450-550 meters elevation, will immediately reduce the searchable set to those trials run within those altitudes. Two or three questions later, not only will the data set be at a manageable size, but the available choices will represent the presence of expert knowledge in the field.

CD-ROMs containing specialized databases may provide an excellent medium for piloting and ultimately distributing expert systems software. The use of expert systems may provide agricultural specialists a unique opportunity to disseminate more than their data.

In summary, expert systems provide a means to devise tools that can assist agricultural specialists and can fill a unique role in the communication and dissemination of agricultural information. In the short term, exploratory efforts are likely to reveal some useful applications. In the longer term, expert systems programming and publication will become commonplace in information centers and libraries.

Conclusion

Libraries and information centers can benefit from each of the technologies discussed in this article. Computer-based messaging systems and electronic messaging are in place in many institutions. For those without such facilities, immediate action should be taken for their provision. For those with electronic facilities in place, attempts should be made to fully exploit the potential of the technologies. Electronic mail offers the ability to improve service to users and, at the same time, reduce costs.

Optical media and CD-ROM are in a rapid growth phase and information centers need to budget for the hardware and software that will allow them to provide these media to their users. In providing CD-ROM capabilities, user needs require particular attention. Many libraries now provide online searching via a trained intermediary. With CD-ROM players attached to personal computers, users will be able (and will expect) to access databases themselves. Thus new procedures and methods will be needed.

Scanning technologies are an area ripe for experimentation with good potential for external funding. Projects are needed which are well controlled and adequately evaluated. It is important that the results of these projects be demonstrable and widely disseminated.

Expert systems, especially those which offer advice to library users, are a promising area which should be carefully monitored. Information center managers should be conversant in the terminology of expert systems and should keep abreast of current offerings. A few innovative experiments are underway and the results of these deserve careful scrutiny.

The technologies of the 1990s afford unprecedented opportunity for management, storage, and dissemination of information. Information centers have a very real potential to increase dramatically the value of their role in their organizations and to increase service to their users.

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Sources of Agricultural Information

DOUGLAS E. JONES

ABSTRACT

THE CONCEPT OF AGRICULTURE today embraces not only the traditional areas of food and fiber production, but an increasingly broad spectrum of related subjects and concerns which have become important to this evolving field. This article will provide an overview of the types of agricultural information, the formats now being utilized for its storage and distribution, the organizations which play a role in its creation and dissemination, and, finally, where it may be found or how it may be accessed.

INTRODUCTION

The first part of this article identifies principal sources of agricultural information—who produces it, what forms it takes, and where it comes from; the second part provides a brief look at major library collections where agricultural information may be found or otherwise accessed. Representative examples are provided throughout with suggested sources for fuller and more detailed information.

A necessary concern when considering sources of agricultural information is the different types of agricultural information now available. Books and journals, both popular and scholarly, undoubtedly will continue to be the principal means of providing agricultural information. Theses, dissertations, and conference proceedings are included in this category. Another familiar form is the research report or technical bulletin published by experiment stations, government agencies, or other research organizations. Maps, aerial photographs, and related sources are important for the study of soils, water, plant pathol-

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ogy, and other disciplines. Patents and other types of intellectual property have traditionally been important for agricultural engineering, and now biotechnology, hybridization, and gene splicing make this an even more important type of information. Laws, standards, and official guidelines play an increasingly important role in agriculture whether in the area of farm labor or pesticide application. The widespread use of computers has produced a growing number of numeric and textual databases in electronic format containing everything from weather forecasts to market reports. Many of the organizations discussed later are involved in the production and distribution of information in several of these forms. A fuller review of this topic is contained in the chapter on "Agricultural Literature" in *Information Sources in Agriculture and Food Science* (Lilley, 1981).

Organizations Which Produce Agricultural Information

The organizations involved with the funding, production, or distribution of information fall somewhat naturally into a spectrum ranging from those with primarily local concerns to those with broad regional or international concerns. However, the increasingly interdependent nature of research, technology, and commerce means that even a narrowly focused state agency may need to concern itself with international issues.

Local Level

Major sources of information at the local or state level are colleges and universities. These institutions play a unique and indispensable role in the conduct of basic and applied research, much of which is done in response to the local geoclimatic and socioeconomic conditions.

In the United States, the seventy-two land-grant institutions provide a vast array of agricultural information through the agricultural experiment station and extension service programs. These institutions, together with fifty-three other state universities and twenty-four system administration offices, constitute the National Association of State Universities and Land Grant Colleges (NASULGC) which collectively represents the largest body of researchers and resources for agricultural research and development. Typically, each institution has a college or other similar organizational unit for agriculture with a publication or information section responsible for distributing research and extension materials. The information distributed via official college, agricultural experiment station and extension service bulletins, reports, and other publications represents only a small fraction of the total information generated at such institutions. The remainder is distributed via books, journals, conference proceedings, etc. Additional information on NASULGC members is contained in *Serving the World: The People and Ideas of America's State and Land-Grant Universities* (NASULGC, 1987).

Outside the United States, colleges and universities perform similar roles in generating and distributing information. Although arrangements vary considerably, typically one must contact the appropriate department within the college or university to arrange for publications, and it is not uncommon for materials to be available only on an exchange basis. A variety of national and international directories provide listings of departments within colleges and universities; *World of Learning* (1988) is particularly useful, not only for its international coverage but for its listing of publications by each institution.

Also of importance at the local or state level are the many governmental research and regulatory agencies concerned with agriculture from a variety of public perspectives including marketing, statistics, pesticide and environmental controls, water resources, farm labor, land-use planning, and soil conservation. These agencies tend to be more challenging for libraries to identify and their publications more difficult to acquire systematically. For the United States, the *State Government Research Directory* (Gill & Tufts 1987) is an attempt to identify many of these agencies, and although the list is limited to government-funded research, many regulatory agencies also are included because research is a necessary part of their regulatory responsibility. For information on such agencies outside the U.S., sources such as the *Worlwide Government Directory* (1987) provide a useful, if somewhat limited, list of state or province-level agencies. Also, some subject-specific directories such as *Horticultural Research International* (International Society for Horticultural Science 1981) provide good access to local agencies.

In addition to universities and local governmental agencies there are many private agricultural organizations, the membership of which ranges from professionals to practitioners to interested individuals. In the United States these organizations are largely state-based interest groups, sometimes representing local chapters of a national parent group. The *Directory of American Agriculture* (1989), for example, lists over 4,000 such organizations on a state-by-state basis. Generally, the publications of these groups are limited to newsletters and public awareness pamphlets; however, many also publish substantive reports of enduring local or even national interest. Acquisition of these documents tends to be difficult and scattered at best, and, therefore, bibliographic control of these materials very poor.

National Level

The principal sources of information at this level are the national governments, national research organizations, and companies or corporations involved in agricultural research. The United States will be discussed as an example of national government information sources.

The U.S. federal government is one of the largest sources of agricultural information in the world by virtue of the studies done by federal researchers, as well as federally funded research conducted by both public and private research organizations. For example, in 1988 the AGRICOLA (Agricultural Online Access) database listed over 1,500 U.S. Department of Agriculture (USDA) publications and the National Technical Information Service (NTIS) database of technical reports listed over 760 items sponsored by the USDA. Distribution is largely accomplished through either the Government Printing Office (GPO) or the National Technical Information Service. In addition, many federal agencies regularly distribute information beyond what is made available via the GPO or the NTIS.

Publications originating from regional branches of federal agencies represent a special concern because many are not made available to either GPO or NTIS for further distribution and bibliographic control. Federal depository librarians have long been concerned by these "fugitive" documents (Bower, 1989) which are often referred to in press releases, editorials, journal articles, or other federal documents, but which are essentially "lost" and difficult to obtain or even identify accurately.

There is a disturbing trend, unfortunately, toward less federal information being distributed through the Government Printing Office. For the years 1980-82, a tally of the USDA entries in the *Monthly Catalog of U.S. Government Publications* (MoCat) shows a total of 5,025 publications listed or an average of 1,675 publications per year. During the period 1986-88, the latest years available, the total number of entries is down to 3,734 or an average of 1,245 publications per year, an average decrease of 430 items per year or 26 percent. It is possible, of course, that there were actually 26 percent fewer documents produced by the USDA during that same time period; however, this seems highly unlikely. What seems more likely is that there are more fugitive documents, and/or more information is being stored in electronic format and not "published" in a customary way. Agricultural librarians used to relying on the federal depository library program as a passive way of acquiring government documents may need to be increasingly wary of such an approach.

It is not yet clear how, or even whether, access to the vast amount of information now being generated in electronic format by federal agencies and its contractors will be managed. Kranich (1989) provides an insightful and disturbing assessment of this issue and its potential impact on agricultural information users. The cost reduction philosophy behind the *Management of Federal Information Resources* guidelines (United States. Office of Management and Budget, 1985) is in direct conflict with the equal access to information policy under which most libraries operate. Perhaps most disturbing is the definition generally used by the Office of Management and Budget (OMB) which suggests that machine-readable data files are generally not considered government publications and are therefore not subject to the same accessibility and dissemination guidelines as other government information.

In addition, the OMB circular strongly encourages dissemination through private sources which raises a host of concerns including currency, cost, accessibility, and long-term availability.

The USDA is, of course, most prominent as a source of agricultural information. It is comprised of forty-nine major agencies, the titles of which serve as a veritable catalog of the subjects and concerns of modern agriculture, from soil conservation and commodity credit to human nutrition and world agriculture. In addition, a variety of other federal departments and agencies provide vital information for agricultural interests. Within the Department of Interior, for example, the Bureau of Reclamation, Bureau of Land Management, and, to a lesser extent, the Fish and Wildlife Service and the Park Service conduct a great deal of research related to water resources, grazing, and watershed management, fisheries and forestry. Even within an agency such as the Department of Defense there are units such as the Army Corps of Engineers and the Defense Mapping Agency which produce research reports and maps of interest to agricultural researchers.

Maps and atlases are often overlooked as sources of agricultural information, yet they provide unique and readily comprehensible information on topics such as soils, water, vegetation, desertification, climate, disease, and pest distribution. Soil survey maps such as those prepared by the U.S. Soil Conservation Service are a familiar example. The quality and usefulness of thematic maps and atlases is not as widely appreciated as it should be. For additional information, *Map Librarianship* (Larsgaard, 1987) provides an excellent overview and useful bibliographies. New remote sensing techniques are being applied to a variety of agricultural concerns. The Earth Resources Observation System (EROS) Data Center located in Sioux Falls, South Dakota, for example, provides access to over 11 million images and photographs. The *Remote Sensing Sourcebook* (Carter, 1986) is a comprehensive worldwide guide to these sources of information.

Another unique source of agricultural information is the patent, an increasingly important component in technology transfer. Most of the major advances in agricultural engineering and machinery, agricultural chemicals and pharmaceuticals, and, more recently, biotechnology (including genetic engineering, tissue culture, and enzymes) can be documented in the patent literature. Plant patents for asexually reproduced new plant varieties are also handled by the Patent and Trademark Office (PTO). Copies of patents are available from the PTO, from patent depository libraries located throughout the United States, and through a variety of document delivery services. New sexually reproduced cultivars are protected through the Plant Variety Protection Office which is a part of the Agricultural Marketing Service of the USDA. Evenson (1989) provides an interesting overview of this topic using patents as a basis for studying technology transfer and agricultural competitiveness. Several guides are available which provide detailed information on sources of patent information in other countries—for example, *Patents Throughout the World* (Greene, 1985) and *Patent Information and Documentation in Western Europe* (Bank et al., 1981).

While the size and complexity of U. S. government agricultural research make it unique, organizational structures and sources of agricultural information of most other national governments address similar concerns in recognizably common patterns. In the United Kingdom, for example, one finds the Ministry of Agriculture, Fisheries and Food (MAFF) and the Agricultural Research Council (ARC) with their various departments, institutes, and stations. Her Majesty's Stationery Office (HMSO) publishes many of the official materials while the individual agencies also publish a large number independently. Readers are referred to the *Worldwide Government Directory with International Organizations* (Gill & Tufts, 1987) or the *Europa Yearbook* (1988) for country by country listings. In addition, many country-specific and region-specific yearbooks and handbooks provide more detailed agency listings.

Regional, International, and Professional Organizations

In the second half of the twentieth century, professional associations and research organizations have become major sources of information through their sponsorship of research; publication of journals, books, and reports; establishment of standards; and organization of conferences. The number and variety of these organizations reveal a vast network of communication and common concerns. For example, the *Agricultural Research Centres* (1988) directory and encyclopedias of associations (Koek K. E., 1989; Burek et al., 1989) list over 15,000 agricultural organizations. The range of subjects and geographical coverage represent the entire spectrum of current agricultural interests, from the Crawfish Research Center at the University of Southwestern Louisiana to the Consultative Group on International Agricultural Research (CGIAR) with its thirteen institutions spread throughout the world. The following list, while highly selective, identifies some of the major associations and research centers in a variety of areas.

An excellent example of a national organization concerned with agriculture across several disciplines is the American Society of Agronomy (ASA) located in Madison, Wisconsin. It currently has over 12,000 members concerned with crop production and soil management and publishes five major journals, two directories, and monographic and special publication series.

At the regional and international level are several important organizations. Perhaps foremost is the Food and Agriculture Organization of the United Nations (FAO), headquartered in Rome with a staff of 7,000 and a budget of $250 million. Its broad goals of increasing agricultural production, raising nutritional levels, and improving the quality of rural life are appropriately addressed primarily to developing countries where the need to provide food and clothing is critical as a basis for further development. FAO produces a variety of journals, reports, indexes (including the AGRIS database), handbooks, and training manuals. These include practical materials designed for the farmer in developing countries as well as research materials for scientists and engineers. A special microfiche program is available which automatically provides copies of all publications listed in *FAO Documentation: Current Bibliography* (United Nations, 1972) including the useful, but otherwise difficult to acquire, working documents and field reports.

The Consultative Group on International Agricultural Research (CGIAR) also focuses on research designed to meet the needs of developing countries. Based in Washington, D.C., and supported in part by the World Bank, FAO and the United Nations Development Programme (UNDP), CGIAR supports thirteen specialized international agricultural research organizations such as the Centro Internacional de Agricultura Tropical (CIAT), International Rice Research Institute (IRRI), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), and the International Livestock Centre for Africa (ILCA).

In addition, many regional organizations have been formed to address common concerns. CAB International in Wallingford, England, is one of the best known and broadly based with representatives of Commonwealth and other nations and territories. Its many specialized bureaus and research centers not only conduct research of worldwide interest, but the library collections serve as the basis for the highly regarded CAB abstract journals. The Asian Productivity Organization (Tokyo), consisting of seventeen Asian and Pacific governments, serves as a think tank and catalyst for research on problems in that region of the world as well as providing training, consulting services, and publications—e.g., newsletters, books, and conference proceedings. A similar organization in the Americas is the Interamerican Institute for Cooperation on Agriculture (IICA). Based in San Jose, Costa Rica, it includes members from the Organization of American States and focuses on research, training, and rural development. A large publication effort includes training manuals, reports, journals, indexes, and bibliographies. A unique award offered by IICA is the Inter-American Agricultural Award for the Participation of Women in Rural Development.

Other types of organizations critical to agricultural research and the provision of information are those which play a large role in funding research but generally do not directly conduct it. *Agricultural Assistance Sources* published by the International Agricultural Development Service (1982) provides an excellent overview of the primary organizations providing international agricultural assistance including scope, interests, addresses, and brief bibliographies. In addition to providing funding, most sponsor conferences and publish reports, monographs, manuals, and newsletters.

The multilingual or regional organizations are among the best known. Foremost among these is the World Bank, based in Washington, D.C., which serves as one of the largest single sources of aid for agricultural research and development in Third World countries. Founded in 1945, the World Bank consists of three institutions: the International Bank for Reconstruction and Development (IBRD), the International Development Association (IDA), and the International Finance Corporation (IFC). Other important agencies of this type include the Arab Fund for Economic and Social Development (Safat, Kuwait), the African Development Bank (Abidjan, Ivory Coast), the Asian Development Bank (Manila, Phillipines), the Inter-American Development Bank (Washington, D.C.), and the International Fund for Agricultural Development (IFAD) (Rome).

In addition, many private, nonprofit institutions provide significant funding for agricultural research and development. Representative institutions include the Winrock International Institute for Agricultural Development (Morrilton, Arkansas), and the International Development Research Centre (IDRC) (Ottawa, Canada), the Ford Foundation (New York), and the Saudi Fund for Development (Riyadh, Saudi Arabia).

Bilateral assistance organizations constitute the third major funding group and the largest source of funding. The U.S. Agency for International Development (USAID) located in Washington, D.C., ranks at the forefront of such organizations, along with the Canadian International Development Agency (CIDA) in Quebec, Canada, the Swedish International Development Authority (SIDA) in Stockholm, Sweden, as well as many other European and Pacific Rim countries.

Beyond the large agricultural organizations with broad interests are many with a more specialized focus such as professional societies and trade associations. At the national level, one finds examples such as the Soil Science Society of America (SSSA) with over 6,000 members and a budget of $750,000. It publishes three of the principal journals in the field as well as a special publication series. A related organization is the Soil and Water Conservation Society with 14,000 members and a budget of $900,000. Its twenty-five standing committees reflect a wide range of interests. Similar to SSSA, it publishes one of the premier research journals in the field as well as a variety of monographs and technical reports. The American Society of Agricultural Engineers (ASAE), another major professional society with some 9,000 members and a $2.5 million budget, not only publishes journals and monographs, but, like many of its engineering society counterparts, provides a large number of technical reports on microfiche and establishes standards and specifications for equipment and structures. Similarly, the Association of Official Analytical Chemists (AOAC), formerly the Association of Official Agricultural Chemists, publishes *Official Methods of Analysis* (Williams, 1984) which is recognized throughout the world as the authoritative source in this area. AOAC also publishes a variety of journals, books, conference proceedings, and manuals. Two examples of soil and water engineering organizations at the international level are the International Institute for Land Reclamation and Improvement (ILRI) in the Netherlands, which is particularly concerned with management of land and water resources in developing countries, and the International Commission on Irrigation and Drainage (ICID) in New Delhi, India, which is largely concerned with irrigation, drainage, and flood control and strongly encourages not only engineers, but economists, ecologists, social scientists, and agricultural specialists to address these topics.

The plant sciences have general associations as well as ones for most individual cultivars. The Crop Science Society of America (CSSA), based in Madison, Wisconsin, has sixteen standing committees addressing a broad spectrum of concerns relating to field crops. Its journals and other publications are recognized as standard works in the field. Among the many noteworthy international organizations is the Netherlands-based International Society for Horticultural Science (ISHS) whose membership includes both scientists and institutions from eighty-six countries around the world. Its journals, conference proceedings, and research directory, *Horticultural Research International,* are recognized worldwide for their quality and timeliness.

Several regional organizations are important as specialized sources of information. The Asian Vegetable Research and Development Center (AVRDC), headquartered in Taiwan with representatives from Germany, Japan, China, Phillipines, Korea, Thailand, and the U.S., is dedicated to research in the development of crops in the humid and subhumid tropics. The International Institute of Tropical Agriculture (IITA) located in Ibadan, Nigeria, performs a similar function with a focus on tropical crops such as maize, cowpeas, soybeans, and cassava. Dryland agriculture poses unique problems for an increasingly large number of farmers using marginal land and water resources. One response has been the establishment of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India which focuses on improved plant varieties and methods of soil and water management.

Concerns about seed quality and availability have fostered many organizations and professional societies concerned with seed science and technology as well as the seed trade. In the United States, for example, the American Seed Trade Association (ASTA), located in Washington, D.C., includes fifty-three state groups representing breeders, growers, wholesalers, and retailers of all types of seeds. Established in 1883, ASTA has a long history of research and publication addressing the needs of the seed industry. The International Seed Testing Association (ISTA), with headquarters in Zurich, Switzerland, develops, publishes, and promotes the uniform application of standard procedures for sampling and testing seeds. In addition, ISTA promotes research in all areas of seed science and technology and publishes journals, conference proceedings, handbooks, and a glossary.

Crop protection is another area well represented by active research centers and societies at national, regional, and international levels. A national example is the Entomological Society of America (ESA) based in Lanham, Maryland, which has over 9,000 members and a budget of $1.5 million; its many committees and sections range in interest from "Systematics" to "Extension and Regulatory Entomology" and its journals, reference standards, and tests represent basic works in this field. A well-known and important agency at the regional level is the European and Mediterranean Plant Protection Organization (EPPO) which, as the name suggests, emphasizes crop and forest protection in Europe. Based in Paris, it publishes two journals and numerous technical reports. Of somewhat broader scope is the International Centre of Insect Physiology and Ecology (ICIPE), based in Nairobi, Kenya. Its aim is to promote advanced insect biology research, provide advanced training to selected fellows, and contribute to increased food production by studying pests of major crops (such as sorghum shootflies and cereal stemborers) and livestock diseases (such as tsetse flies, ticks, and other disease vectors), especially those plaguing developing countries.

A related area of widespread interest and research is weed science. The Weed Science Society of America (WSSA), located in Champaign, Illinois, is a key organization with members from academe, industry, and regulatory agencies. It publishes two major journals and sponsors an annual convention. The European Weed Research Society (EWRS), headquartered in West Germany, includes members from over forty countries and focuses on communication, education, and training through the publication of journals, conference proceedings, and a directory. The International Weed Science Society (IWSS) in Corvallis, Oregon, fosters communication between the many weed science and related societies. While it is neither as large nor as active as the other two organizations, it nevertheless provides a very important liaison function as well as encouraging research and sponsoring symposiums.

Forestry and range management have assumed an increasingly larger role in agricultural research because of their impact on watershed management and soil conservation. The fuelwood crisis in much of the Third World also has pushed agroforestry forward as a major research area. Two examples of national organizations are the Society of American Foresters (SAF) and the Society for Range Management (SRM). Each publishes a number of key journals and other technical materials important to research in this area. Internationally there are many noteworthy organizations including the International Union of Forestry Research Organizations (IUFRO), representing over 15,000 scientists from 102 countries, and the International Council for Research in Agroforestry (ICRAF), which conducts studies and promotes research on joint land use problems in the tropics.

The area of animal science and livestock production includes an almost bewildering array of professional organizations and societies. In addition to organizations concerned generally with animal production, health, welfare, and nutrition, it is probably safe to say that almost every type and breed of animal has one or more societies fostering research, publication, and education about it alone, from stately limousin cattle to the lowly opossum. The examples in the later discussion are purely illustrative and cannot begin to represent the range of organizations producing animal science information. However, directories such as *Agricultural Research Centres* (1988) and the encyclopedias of associations (Koek, K. E., 1989; Burek et al., 1989) are excellent starting points for additional information. The American Society of Animal Science (ASAS), located in Champaign, Illinois, is concerned with all aspects of animal production and processing, including livestock products. With over 4,500 members and four regional associations, it represents a major source in the production and dissemination of animal science information. At the international level are research organizations such as the International Livestock Centre for Africa (ILCA) based in Addis Ababa, Ethiopia, which emphasizes research on livestock production systems, especially ruminant livestock, for developing countries. ILCA not only conducts and publishes research, it also has embarked on a program to collect, microfiche, and index regional livestock literature. A more specialized area such as aquaculture, for example, has a variety of national, regional, and international organizations which sponsor and/or conduct research as well as publish the major journals in the field. The American Fisheries Society (AFS), founded in 1870 and now located in Bethesda, Maryland, has over 8,500 members and four regional groups representing all types of aquatic science professionals. Its three journals are among the core publications in the field. In addition, it produces a directory, books, and special publications. The World Aquaculture Society (WAS) in Baton Rouge, Louisiana, includes both plants and animals in its scope. It is international in scope and includes libraries and research institutions as well as individuals among its 2,300 members. Its journal and annual conference proceedings represent an important source of literature for the field.

This brief survey of organizations producing information would be remiss in not mentioning two additional areas critical to agriculture—money and people—that is agricultural economics and rural sociology. The American Agricultural Economics Association (AAEA), located in Ames, Iowa, has long been a major force in research, teaching, and publication. Its 4,500 members represent professionals from government, industry, and academe and its journals are key sources of information. An important example on a regional level is the Organisation for Economic Co-operation and Development (OECD) with headquarters in Paris. While the scope of OECD research and publication goes well beyond agriculture, it is nevertheless a key source of information on the economic aspects of European agriculture, fisheries, and environment as well as world trade and aid for developing countries. Among organizations which provide sociological research and information, one cannot overlook the American Farm Bureau Federation (AFBF), headquartered in Park Ridge, Illinois, with over 3 million members, and the National Grange (NG), in Washington, D.C., with 400,000 members. The research done by both organizations is largely geared to solving local problems and supporting political action, but their concerns reflect the critical needs of farmers today. On a more scholarly level there is the International Rural Sociology Association (IRSA), currently located at Michigan State University in East Lansing, Michigan, with a membership of 1,600 rural sociologists and other social science professionals around the world. As with other such organizations, it fosters communication and research, sponsors conferences, and publishes a directory.

This review of organizations involved with the creation and dissemination of agricultural information provides evidence of two trends which portend important and challenging issues for agricultural libraries. First, there is significant growth in the number of such organizations—because of an increasing number of new or more specialized subject areas and because such organizations are being formed in states and countries where they did not previously exist. One result is that it is simply more difficult to identify, bring under bibliographic control, and provide physical access to the publications of such organizations. Librarians and documentalists must recognize this challenge and set in motion the information-harnessing apparatus necessary to deal with it. That may include educating policy makers and the governing boards of societies; it may include more networking and cooperative collection development among libraries at all levels, perhaps even the establishment of regional clearinghouses with responsibilities for both bibliographic and document control; and it may include some technological "fixes" such as optical scanning of elusive or local interest documents coupled with high-density storage technology. A second, related trend toward the formation of interdisciplinary associations further complicates the problem because it may well be more difficult to recognize such organizations and, once identified, the publications may be harder to classify and represent by subject headings. Subject areas such as environmental protection, global warming, biotechnology, technology transfer, and complex systems draw upon so many different disciplines for definition and methodologies that new terms and concepts are needed to intellectually corral them and make them accessible to others.

Commercial Publishers

Commercial publishers play a major role in the distribution of agricultural information through both journal and book publishing. Few publishers concentrate exclusively or even primarily on agriculture, but most major science publishers such as Elsevier Applied Science

Publishers, Pergamon Press, Butterworths & Co., Academic Press, Interstate Printers and Publishers, Springer-Verlag, Paul Parey, Lewis Publishers, A. A. Balkema Publishers, and CRC Press, to mention but a few, are active in agricultural publication. One interesting development in the last fifteen years has been for some professional associations and societies to turn the printing, distribution, and marketing of their journals, and sometimes books, over to commercial publishers while retaining editorial control at the society. Frequently this is done in recognition of the fact that publishing today requires the full-time efforts of both clerks and highly skilled professionals to deal with a variety of tasks from editing and printing to marketing, mailing, and subscription maintenance. It is not clear if this trend will continue or diminish, especially given the current widespread concern over serial price increases.

Another interesting phenomenon in recent years has been the amazing number of acquisitions and mergers of publishers. One result of that process has been increased centralization of press ownership among a few individuals and corporations, most of which are non-United States. The implications of this are not clear, but there is concern about monopolization and manipulation of the market system which might have significant consequences for the availability of information. University presses provide an important, although relatively small, supply of scholarly works, often based on regional or special subject interests. One concern apparently shared by both large and small presses is the difficulty of finding good scientific authors. Frequently, the most knowledgeable experts are so involved with research or other commitments that they cannot afford the time professionally to write the many books that probably should be written. Faculty seeking promotion and tenure may feel that six articles will carry more weight with peer review committees and administrators than one book. Hence, journals and conference proceedings continue to flourish. There are many positive aspects of commercial publication including the fact that materials can be easily identified and readily obtained. Generally speaking, the editing, typography, and graphics of books and journals today are of high quality, due in part to the high level of technology throughout the publishing process.

Computers and Sources of Agricultural Information

Computer-readable information sources deserve special mention because they present rather unique concerns and possibilities. There is a considerable body of agriculture-related software now available for tasks such as recordkeeping, management of crops and livestock, irrigation and fertilizer calculations, feed formulation, and vehicle maintenance. Some agencies, such as the state extension services in the United States, provide some software at no charge or for a small fee. Major software directories such as the *Software Catalog: Microcomputers*

(1989) and *Data Sources: Software* (1989) provide up-to-date listings by subject of commercially available programs.

Machine-readable databases are rapidly becoming the standard format for numeric information although some of that information also continues to be published in paper or microform. The range of information and sources is quite broad, including marketing and production data for crops and livestock; animal and human food; nutrition and consumption data; and soil, weather, and environmental data. National and state governments tend to be the chief collectors of this information, but, as mentioned earlier, their role in disseminating or making this information available is not yet clear. Evinger (1988) has surveyed U.S. federal agencies and compiled a list of *Federal Statistical Data Bases* which provides a brief description and availability information. The *Federal Data Base Finder* (Zarozny, 1987) also helps to identify many relevant sources. NTIS serves as a distributor of some federally produced software and databases, although their holdings represent a small portion of what is available. A slightly dated, but nevertheless useful, source is the *Agricultural Databases Directory* (Williams & Robbins, 1985). It includes information on 428 databases, both textual and numeric, from the well known *Computer-Readable Databases* (Williams, 1985) and additional information is provided on databases produced by some sixty extension services. The *Directory of United Nations Databases and Information Systems* (United Nations, 1985) provides descriptions of the many agriculture-related files maintained by the United Nations including their currency, scope, and availability.

A broad range of private, corporate, and governmental organizations provide funding for agricultural research, teaching, and study. Among the many guides and directories which list such funding sources is the *DRG: Directory of Research Grants* (1989), which provides a brief description of over 2,000 programs supported by federal and state governments, private foundations, corporations, and professional associations. In addition, the *Foundation Grants Index* provides information on grants awarded annually by over 400 major private foundations representing more than 20,000 new award listings each year (Kovacs, 1988). Both are available in print and online. In addition, the University of Illinois maintains a continuously updated list of research funding opportunities through the Illinois Research Information Service (IRIS). This list is available only online. With listings for over 4,000 funding opportunities available from both federal and nonfederal sponsors, it represents one of the largest and most comprehensive sources of current funding information.

Of special interest to U.S. researchers and those who help them find information is the USDA's Current Research Information Service (CRIS), a computer-based documentation and reporting system designed to track current publicly supported agricultural and forestry research projects. Each of the more than 30,000 records now available includes key information about the investigator, performing organization, sponsoring organization, objectives, approaches, progress, and publications. CRIS is available online and recently has been put on a CD-ROM. The *Federal Research in Progress* (FEDRIP) database, compiled and distributed by NTIS, includes records submitted by the USDA as well as other records of potential interest from the Department of Energy, the National Aeronautics and Space Administration, National Institutes of Health, and the U.S. Geological Survey. It is available through DIALOG Information Services.

The principal bibliographic databases—AGRICOLA, CAB, and AGRIS—are discussed in detail in the article by Sarah Thomas, "Bibliographic Control and Agriculture," in this issue of *Library Trends*. However, there are several other bibliographic databases which supplement those three. For example, additional information on agricultural economics and the business aspects of agriculture can be found in the PTS F&S Index and PTS PROMPT, both produced by Predicasts, which focus on business magazines, newspapers, and trade journals to provide coverage on companies, new products or technologies, industry reports, regulations, sociopolitical factors, and related information. A related database, produced by Pioneer Hi-Bred International, is AGRIBUSINESS U.S.A., which covers all aspects of agribusiness including the crop and livestock industries, chemicals, biotechnology, finance, equipment, and marketing. A unique aspect of this database is that it includes bibliographic, limited full-text items, and statistical tables.

Food Science and Technology Abstracts and Foods Adlibra focus on processing—that is, turning the raw agricultural products into the foods that appear on grocery shelves. Subjects include vegetables, meats, drinks (wine as well as milk), and all aspects of processing and storage. Coffee drinkers may be interested to know that there is even a database devoted to that one amazingly popular drink—Coffeeline produced by the International Coffee Organization in London. For those interested in fish there is Aquatic Sciences and Fisheries Abstracts (ASFA) produced jointly by the National Oceanic and Atmospheric Administration and Cambridge Scientific Abstracts. ASFA covers both aquaculture and marine fisheries topics selected from over 5,000 sources of primary information. Selected Water Resources Abstracts, produced by the Department of the Interior, provides access to a broad range of materials dealing with water resources economics and planning, hydrology, irrigation, and water quality. It represents materials identified at over fifty water research centers and institutes in the United States.

Several directory-type databases are now available in the agricultural chemical field which provide detailed information such as one would expect to find in a handbook on the variety of chemicals used in agriculture. Among these are the Agrochemicals Handbook and the European Directory of Agrochemical Products, both from the Royal

Society of Chemistry, as well as the Pesticide Databank, jointly produced by the British Crop Protection Council and CAB International.

Agricultural Libraries

Francis Crick, Nobel laureate and one of the discoverers of the molecular structure of DNA, has observed that "communication is the essence of science" (Crick, 1979). The first part of this article has examined one part of the communication process—the creation of agricultural information from its many sources and in its many forms. Another critical part of this large-scale communication process is storing and making available what has been created so that the link between one mind and another will be complete. By far the most widespread and successful means of fulfilling that mission to date has been through the creation of libraries where materials are acquired, bibliographically controlled, and systematically housed so that users can retrieve a book or journal directly. In the second half of this century, however, libraries—especially research libraries—are evolving toward a much more complex model in which physical collections will continue to be fundamental to the library, but, in addition, there will be increased systematic or planned reliance on other collections as well as increased utilization of electronic formats such as locally available CD-ROMs or remotely accessed full-text databases. The largest and best agricultural libraries are generally affiliated with the largest and best agricultural research programs. In the United States, for example, the older and larger land-grant institutions have generally excellent agricultural collections, most with special strengths important for regional research interests. The U. S. National Agricultural Library (NAL) houses perhaps the largest and richest collection of agricultural and forestry-related materials in the world and is especially strong in Americana but replete with materials from around the world. In addition, other major libraries house impressive, often unique, collections. For example, the U.S. Department of Interior library contains one of the largest collections on natural resources, reclamation, conservation, fish, and wildlife. Important specialized collections such as those on post-harvest storage technology at the Department of the Interior or the arid lands collection at the University of Arizona represent special strengths. The *Directory of Special Libraries and Information Centers* (1989) provides detailed descriptions of hundreds of special agriculture-related libraries throughout the United States and Canada. In the United Kingdom, the CAB International libraries, located at the various Commonwealth research bureaus and institutes, collectively represent very strong European materials as well as literature from developing countries. Agricultural holdings in the British Library are truly impressive with special strengths in twentieth-century journals and conference proceedings from around the world. The immensity of the British Library collection plus the outstanding document delivery service provided by the Lending Division have made it one of the best known and most frequently used document delivery services in the world. In the related areas of natural history, ecology, and conservation the library of the British Museum (Natural History) surely ranks as one of the world's best collections.

In addition to strong national library collections, most countries also have specialized libraries associated with major agricultural research organizations. The FAO library in Rome contains an impressive collection which is especially strong in materials from Africa, South America, and Asia. It also includes the holdings of the former International Institute of Agriculture Library. Another example of a specialized research collection is that of the International Rice Research Institute in the Phillipines which attempts to collect rice-related materials comprehensively. IRRI is now considering the feasibility of publishing the institute's many publications on CD-ROM.

CONCLUSIONS

The success of the agricultural enterprise in today's world is as critical to the success of society as it was 5,000 years ago, in fact, perhaps more so today. The effectiveness and efficiency with which a country or a people produce the food and fiber necessary to meet basic human needs is a basic measure of the quality of life. The types and sources of agricultural information reviewed here reveal a variety, complexity, and mass of information. The books, journals, conference proceedings, maps, theses, reports, remote sensing imagery, patents, and other types of information emanating from tens of thousands of sources are a testament to the richness of the field which must somehow be managed. It also suggests a commitment and concern on the part of individuals and governments in every part of the world to improve that effectiveness and efficiency. Our task as librarians is to facilitate the communication process, to ensure that researcher *A* can identify and get access to what researcher *B* has learned, to make sure that those involved in technology transfer at whatever level have the resources to do their job, and to ensure that policy makers and the general public have access to appropriate information.

The questions which present themselves are challenging ones and are certainly not unique to agricultural libraries. Since no single library can collect everything, what should it try to collect? What agreements can be reached between libraries to try to ensure that nonephemeral materials are collected somewhere? How can the identification and bibliographic control of materials be improved? How can technology be used to facilitate the storage and retrieval of information?

Perhaps the best answer is that librarians must be proactive. They must educate themselves and others about the problems and concerns they face. "Others" includes not only users but administrators, policy makers, legislators, and the public. Librarians need to work actively with the sources of information—e.g., publishers, professional associations, government agencies, etc.—to make them aware of problems and, it is hoped, become a part of the solution. Perhaps the model used by the Engineering Societies Library (ESL), in which the professional engineering associations actively deposit their materials with ESL in exchange for their long-term storage and listing in *Engineering Index*, could be aggressively pursued by NAL and other national libraries. Agricultural librarians should be encouraged to publish in appropriate agricultural journals as well as library journals. Existing organizations, such as the American Library Association, the Special Libraries Association, and the International Association of Agricultural Librarians and Documentalists, can provide effective forums for discussion and action. The newly formed United States Agricultural Information Network (USAIN) has a unique opportunity to play an important role in addressing this and other related issues. As it becomes increasingly difficult for libraries to acquire as much information as they and their users believe they need, libraries must focus more attention on the issues of access to information beyond the local level and to making access more readily available and hassle-free. Perhaps it is time to consider more seriously such seemingly farfetched notions as computerized clearinghouses of electronically scanned documents using the library as a gateway. Indeed, many documents and databases are now essentially "uncollectable" because they are available only on a computer somewhere and known to only a few. As newer computer technologies make older ones obsolete, such information is at risk of being lost forever. It is hoped that new storage technologies such as CD-ROMs, in conjunction with systematic information management policies, will provide the means to address this concern.

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A Selected Annotated Bibliography of Agricultural Information

JAMES E. BIRD AND JESSIE C. SMITH

ABSTRACT

THE LITERATURE OF AGRICULTURE and its related fields has proliferated as nations throughout the world have become engaged in major agricultural activities and research. Today's expanding information technology has an increasing impact on the management, control, and dissemination of this agricultural information. As in all disciplines, key documents have helped to shape and define the boundaries of discussion. These documents, although static in nature, form a foundation which allows the discipline to grow in the future. The authors of the twelve articles in this publication have discussed major issues and trends in agricultural information and agricultural libraries and, in doing so, have relied upon the diverse and expanding literature on agricultural information.

In the selective annotated bibliography that follows. Emphasis has been placed on resources which discuss current and future trends in agricultural information and libraries, user needs, issues facing developing countries, technology advances, and special problems. These documents provide a framework for understanding the current and future status of agricultural information and agricultural libraries. By no means do they exhaust the wealth of publications that cover the various agricultural information topics and issues discussed in this volume.

This bibliography is divided into twelve sections. The first eleven reflect the topics discussed in this volume. The concluding section includes documents that are either very broad in scope or do not conveniently fit into a specific subject section. Within each section, documents are listed alphabetically by first author.

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Documents were identified for inclusion in this annotated bibliography through discussions with the issue's editors, by examining the literature cited by other article authors, by conducting both manual and online searches of the library and agricultural literature, and by checking both published and unpublished bibliographies. An attempt has been made to give equal treatment to all subject areas covered in this issue. It should be noted that in some areas there is overlap and annotations placed in one section could conceivably be placed in others as well. The section on lesser developed countries does, however, contain more citations than other areas. This was necessary because topics in this area include all phases of agricultural information, not just discrete areas such as collection management or document delivery.

All of the documents included in this annotated bibliography were examined at either the National Agricultural Library (NAL) or the libraries of the University of Maryland at College Park and Eastern Shore campuses.

Historical Perspective

Blanchard, J. R. (1977). The history of agricultural libraries in the United States. In A. Fusonie & L. Moran (Eds.), *Agricultural literature: Proud heritage, future promise (a bicentennial symposium)* (pp. 219-35). Washington, DC: Associates of the National Agricultural Library.

Blanchard traces the development of agricultural libraries in the United States from the small agricultural library collections at the Philadelphia and New York societies for the promotion of agriculture in the late eighteenth century to the twentieth century. A history of the development of various types of agricultural libraries is presented, including U.S. government, land-grant college, and experiment station libraries. A detailed look at the history of the National Agricultural Library is presented. The extensive list of references cited provides an excellent reading list for information on the history of agricultural libraries in the United States.

Farley, R. A. (1977). The development of agricultural libraries in the United States: A commentary. In A. Fusonie & L. Moran (Eds.), *Agricultural literature: Proud heritage future promise (a bicentennial symposium)* (pp. 237-42). Washington, DC: Associates of the National Agricultural Library.

Farley expands upon various points discussed by Blanchard (see above) in his history of agricultural libraries in the United States and focuses on the centralization of the U.S. Department of Agriculture's (USDA) library system in the late nineteenth century. A letter from William P. Cutter, the first librarian of the USDA, to the Secretary of Agriculture concerning the recall of books from various divisions within the USDA to the main library is reprinted in full. The letter provides a fascinating look at the USDA's library system during this time period.

Greathouse, C. H. (1899). Development of agricultural libraries. In *Yearbook of* *the United States Department of Agriculture* (pp. 491-512). Washington, DC: USGPO.

Greathouse traces the history of U.S. agricultural libraries from the founding of the Philadelphia Society for the Promotion of Agriculture in 1785 through the late nineteenth century. Although there is some overlap in coverage with Blanchard (see above), Greathouse provides greater detail on the status and types of agricultural libraries in the nineteenth century and examines society and state board libraries, traveling libraries of agricultural books, grange libraries, public and U.S. government library collections, and agricultural college libraries. Examples of each type of library are given.

Overfield, R. A. (1981). State agricultural experiment stations and the development of the West, 1887-1920: A look at the sources. *Government Publications Review, 8A*(6), 463-472.

Overfield considers sources of information on agricultural experiment stations, showing the scientific role played by these stations, with a focus on the records of the Office of Experiment Stations. These records can be divided into three major sections: (1) office files; (2) records on the insular stations; and (3) the general records of the office. Of the three, the last is the largest and most varied collection, consisting of letters from the public seeking information and publications as well as the correspondence among the Office of Experiment Stations, state stations, and agricultural colleges. Overfield's paper provides the first step in the bibliographic control of any research material, identifying its availability and content.

Thurber, E. (1945). American agricultural college libraries, 1862-1900. *College and Research Libraries, 4*(4,pt.#1), 346-352.

Thurber offers a history of the formation and establishment of state agricultural colleges and their libraries and the role of federal financing of these institutions. Agricultural library collections were built through donations, exchanges, collection transfers, and the government depository system. Budgetary considerations played a major role in collection development but, with the advent of increased appropriations for state agricultural colleges and the formation of agricultural experiment stations in 1887, collections grew. Thurber also briefly discusses the development of library policy statements and patron access to library material. This is an important historical examination of the development of agricultural college libraries.

User Needs and Library Services

Begum, K. J., & Sami, L. K. (1988). Research collaboration in agricultural science. *International Library Review, 20*(1), 57-63.

The authors conducted a study of agricultural research paper authorship patterns based on records taken from *Indian Science*

Abstracts. The increasingly interdisciplinary nature of agricultural science has resulted in papers authored by two or more individuals. Although over the years of the study (late 1970s to early 1980s) most papers were authored by two or more authors, there was no noticeable decline in single author papers. In this type of authorship research, it would have been useful to have a statistical analysis of the trends. Nevertheless, the baseline data provided will help agricultural librarians and documentalists better understand the cross-disciplinary nature of agricultural research which does and will continue to affect user services and collection management practices. The authors' research "indicates that the extent of collaboration is decided by the nature of the discipline" (p. 63).

Colle, R. D. (1989). Communicating scientific knowledge. In J. L. Compton (Ed.), *The transformation of international agricultural research and development* (pp. 59-83). Boulder, CO: Lynne Rienner Publishers.

This article examines how scientific knowledge is communicated in the field of agriculture. Knowing how agricultural knowledge is communicated can have important implications for the organization and operation of agricultural libraries. Colle examines the diffusion of agricultural information and the adoption of this information by researchers, discussing the extension workers' role in this process as a link in the agricultural information communication system. The function of communication planning is examined, including the development and spread of communication media. Colle's discussion provides useful insights for agricultural public service and collection development officers.

Lendvay, O. (1980). *Primer for agricultural libraries* (2nd ed. rev. and enl.). Wageningen, the Netherlands: Centre for Agricultural Publishing and Documentation.

This book is a primer for the organization and development of an agricultural library. Although probably not useful for large-scale operations, the book nevertheless discusses basic elements that should be considered when starting a general agricultural library. Topics include reader or public services, collection development and acquisition processes, instruction in the use of the library, and the administration and management of the library. Appendixes include lists of agricultural indexes and abstracts, bibliographies, serial titles, and other agricultural literature sources.

Olsen, J. K.; Lippincott, J. K.; & Coons, B. (1985). *Cornell University Libraries. A final report from the public research services research projects. Appropriate public services for agricultural research faculty. One of a series of self-studies and research projects.* Washington, DC: Association of Research Libraries, Office of Management Studies (ERIC Document Reproduction Service No. ED 255 220) 60 p.

This report is of a study done at Cornell University's Albert R.

Mann Library (the largest academic agricultural library in the United States) to determine appropriate levels of public services to agricultural research faculty. The study was divided into parts: (1) a survey of faculty library use; (2) a period of expanded and accessible library services to the agricultural research faculty; and (3) a resurvey of the faculty to determine changes in library use patterns because of expanded public services. The overall objectives of the study were to determine the library's role in both the scientific communication process and the academic scientist's process of research and information acquisition. The study's hypothesis, that if services were more accessible and convenient the information resource pattern use of faculty members would be changed was not proven, possibly because of the short time frame of the study and the initial favorable responses to the first survey as noted by one of the study's consultants. However, based on individual responses to the resurvey, the new and expanded services, including free computer literature searches and photocopying, provided impetus for change in use patterns. The faculty ratings of library services and the methods faculty use to keep current on information in their fields provide very useful information in the planning of academic library services. Based on the project's results "the ties between librarians and faculty are being strengthened through implementation of a collection development/liaison model" (p. 20).

Russell, H. M. (1983). Agricultural user populations and their information needs in the industrialized world. *IAALD Quarterly Bulletin, 28*(2), 40-52.

There is an information gap in the knowledge of agricultural user needs. Russell divides the user population into eight categories, discussing in some detail the information needs of each. The categories of users identified are: policy makers and administrators; research scientists; diagnostic, analytical, and industrial scientists; specialist advisors; general advisors; educators and students; agricultural service industries; and farmers and rural people. Russell states that studies to determine user needs should include surveys but should also include direct observation of the various user populations. One such study is discussed where minimum standards of staffing and library collections were determined for various types of agricultural institutions, stations, and organizations.

Sources of Agricultural Information

Advisory Committee for the Co-ordination of Information Systems (ACCIS). (1987). *ACCIS guide to United Nations information sources on food and agriculture* (ACCIS Guides to United Nations Information Sources No. 1). Geneva: ACCIS. 124 p.

This is a guide to sources of information on food and agriculture that are available from the United Nations (U.N.) system. It is divided into ten subject areas: Food and agriculture—general; plant production and protection; animal production and health; food and nutrition; land

and water development; economic and social development; trade and commodities; agro-industries and industrial development; fisheries and aquaculture; and statistics. In each section, organizations in the U.N. system are listed as sources of information. For each organization, a brief summary of purpose is given with a list of relevant publications. Annexes give addresses of international organizations and database hosts and a country by country list of addresses of U.N. depository libraries and agricultural information organizations. This is a very useful guide to the myriad agricultural information sources available in the U.N. system.

CAB International. (1988). *CAB thesaurus* (2nd ed.) (vols. 1-2). Wallingford, Oxon, United Kingdom: CABI.

The purpose of the two-volume *CAB Thesaurus* is to enable users of the CABI (CAB International) online database to formulate effective search strategies. However, as the introduction to the thesaurus states, it can be very useful in setting up subject indexing for any collection of agriculturally related documents. The National Agricultural Library adopted the thesaurus in 1985 for subject indexing of the AGRICOLA database. Some 1,500 of the 56,000 terms included in the thesaurus are only used by AGRICOLA indexers and are so indicated. The thesaurus is set up alphabetically with a broader term (BT), narrower term (NT), and related term (RT) coding system. Both BTs and NTs are given in a hierarchical order under each word or phrase in the thesaurus. This thesaurus is of prime importance in searching two of the world's most important agricultural databases, and it is also useful for determining free-text search terms for these and other databases and for providing subject headings and indexing terms for special and departmental agriculturally related libraries.

CAB International. (1988). *CAB International serials checklist.* Wallingford, Oxon, United Kingdom: CABI.

This book includes serials, annual reports, and proceedings of congresses, symposia, seminars, workshops, and other meetings that are examined by CABI specialists to identify material for inclusion in the numerous indexes and abstracts published by CABI. The checklist is divided into five sections, including coverage of the three types of publications noted earlier, an ISBN index, and a list of publishers (with addresses). The 1988 checklist is a precursor to the soon to be published *World List of Agricultural Serials* (a cooperative project between NAL and CABI) which will not only include CABI material but serial publications indexed in AGRICOLA and AGRIS as well.

Frank, R. C. (1984). *Directory of food and nutrition information services and resources.* [Phoenix, AZ]: Oryx Press.

This directory emphasizes U.S. information resources on nutrition education, food service, food service management, and related aspects of applied nutrition. Food and nutrition studies are vital components of agricultural science and this directory offers a variety of information sources in these areas. The nine chapters include: organizations; databases; microcomputer software; journals and newsletters; abstracts, indexes, and current awareness publications; producers of food and nutrition materials; key reference materials; regional, state, and area agencies; and nutrient tables. Almost half of the volume is devoted to organizations, with very detailed annotations, including information on their purpose, services, audience, geographic area served, educational programs, and eligible clientele. Indexes provide rapid access by subject, geographic area, and organization type. There also is an index of training programs approved by the American Dietetic Association.

Harvey, N. (Consulting Ed.). (1986). *Agricultural research centres [:] A world directory of organizations and programmes* (8th ed.) (vols. 1-2). Harlow, Essex, United Kingdom: Longman Group UK Limited.

This two-volume directory of 8,000 agricultural research organizations is essential for agricultural reference work, collection development activities, interlibrary loan, and for facilitating the transfer of information among nations. The arrangement is by country and, within country, alphabetical by organization. Organizations include government research centers, independent and industrial research centers, and educational organizations "which conduct or finance substantial research and development programmes into agriculture...." (introduction) and related sciences. The following information (where available) is presented for each organization—i.e., address, communication links, status, affiliation, directors, sections (organizational), number of graduate research staff, annual expenditures, activities, and publications. Organization title, acronym, and subject indexes facilitate access. This is an essential resource for any agricultural library or document collection.

Johnson, J. S. (1985). *Annotated bibliography on development and transfer of agricultural technology* (Vol. 1). Urbana, IL: INTERPAKS, University of Illinois, Office of International Agriculture. Volume 2. Sfeir, L. (1986). Same title and issuing agency.

These two annotated bibliographies form a valuable compendium of information on the development and transfer of agricultural technology in both developed and developing countries. Volume 1 is presented in five parts: agricultural development—general; policy and planning; technology development; technology transfer; and technology utilization. Volume 2 keeps these subdivisions but adds a sixth—sources of technical reference materials. Annotations in both volumes are descriptive and informative. Each volume has an author, title, and subject index with volume 2 containing cumulative indexes for both volumes. These bibliographies should prove essential for those involved with agricultural technology transfer and development.

Morgan, B. (1985). *Keyguide to information sources in agricultural engineering.* London: Mansell Publishing Limited.

This reference work will be of importance to those involved in collection development in agricultural engineering and to reference personnel. The guide is divided into three parts. Part one describes agricultural engineering literature as a whole, examining its history, organization, and classification. Part two is an annotated bibliography of information sources including journals, handbooks, directories, and bibliographic sources; it includes a large section devoted to important monographs and texts arranged by broad subject areas. Part three covers organizational sources of agricultural engineering information, first listing international sources and then covering individual countries.

Collection Development

Blanchard, J. R., & Farrell, L. (Eds.). (1981). *Guide to sources for agricultural and biological research.* Berkeley, CA: University of California Press.

This book is of considerable value to those involved in collection development for an agricultural library as well as to public service staff seeking reference works to respond to agriculturally related inquiries. Material is arranged by broad subject areas such as plant sciences, crop protection, social sciences, and animal sciences. Areas such as animal sciences are broken down into narrower topics such as veterinary medicine and poultry husbandry. Each subject area is divided into types of information sources available (e.g., literature guides, abstracting and indexing services, dictionaries, and encyclopedic sources). Sources before 1958 were not included unless deemed very important for retrospective searching. Each entry contains standard bibliographic information and a brief but knowledgeable annotation. Although somewhat dated, especially concerning nonserial titles, this is an indispensable resource for agricultural collection development, reference work, and research.

Jensen, R. D.; Lamb, C.; & Smith, N. M. (Comps.). (1986). *Agricultural and animal sciences journals and serials[:] An analytical guide* (Annotated bibliographies of serials: A subject approach series). Westport, CT: Greenwood Press.

This compilation of English language agriculturally related serials and journals is intended for collection development activities. Agricultural and animal sciences are divided into subject areas such as agricultural economics, agronomy, horticulture, and veterinary science. There is also a section devoted to indexes and abstracts. Journals and serials were included if, in the compilers' determination, they are major titles that are research oriented. The entries are organized alphabetically under each subject category. Information for each entry includes date started, publication frequency, price, publisher, printed indexes/abstracts and online databases in which the serial or journal is indexed, target audience, and ISSN. Narrative annotations include a synopsis of the subject area covered by the journal or serial and the number and type of papers found in a typical issue. This is a very useful reference work for collection development activities in agricultural and related sciences.

U.S. Department of Agriculture. National Agricultural Library. (1988). *Collection development policy of the National Agricultural Library.* Beltsville, MD: National Agricultural Library.

Collection development policies are important documents for any library. They define the scope of the collection, and, within the scope, the levels of collection intensity for each subject area. They are a guide for both collection development personnel and for users of the collection who need to know the scope and level of the collection. The National Agricultural Library's collection development policy includes a detailed description of the format types of material collected, both print and nonprint, and the definitions of the five levels of collection intensity (from minimum to comprehensive). The main section of the policy is arranged by Library of Congress call number ranges. For each range there is a brief scope statement and one of five levels of collection intensity. There is also an index to words and phrases appearing in the scope statements. This document is indispensable not only to National Agricultural Library personnel but also to those who depend on this library for information and guidance.

Stubban, V. L. (1988). Use of the RLG conspectus as a tool for analyzing and evaluating agricultural collections. *IAALD Quarterly Bulletin, 33*(3), 105-110.

This paper discusses Kansas State University Library's project to evaluate and analyze its agricultural sciences collection using the Research Libraries Group (RLG) conspectus. The RLG conspectus directs that collections be categorized by five collection levels ranging from minimum to comprehensive. The entire project took two months to complete. Conducting an analysis using the RLG conspectus has aided in collection development activities at Kansas State University and has helped identify areas of the collection that need strengthening. The most important point in completing the conspectus was maintaining both a timetable and consistency in the data collected.

Bibliographic Control

Bailey, M. J. (1988). Microfilming state agricultural and forestry documents: Program of the National Agricultural Library. *Microform Review, 17*(2), 72-75.

A discussion of the microfilming of state agricultural experiment station and cooperative extension service and forestry documents, a program initiated by the National Agricultural Library in 1974. Bailey provides an overview of microfilming procedures and looks at the three-point proposal agreed upon by NAL and forty states regarding the indexing of these documents. There is a brief discussion of some new technologies being examined as alternatives to microfilming. An appendix lists the states that have cooperative agreements with NAL for microfilming these documents as well as the vendors doing the actual microfilming. Microfilming these documents not only provides better access to these important but underutilized documents but also assists in preservation.

Chillag, J. (1982). Nonconventional literature in agriculture—An overview. *IAALD Quarterly Bulletin, 27*(1), 2-7.

Grey literature—which includes unpublished reports, theses, and conference proceedings—is a rapidly growing component of agricultural literature. Chillag believes that access to grey or nonconventional literature is important because much valuable literature is produced only in this form. Various reports describing this type of literature in the field of agriculture and related disciplines are examined. The formation of SIGLE (The System for Information on Grey Literature in Europe), a European cooperative project started in 1981, is discussed. The aim of this project is to provide bibliographic control of and increased access to nonconventional literature.

Mathews, E. (1987). Bibliographic access to state agricultural experiment station publications. *IAALD Quarterly Bulletin, 32*(4), 193-199.

State agricultural experiment station documents are a valuable resource for a wide range of users, including agricultural historians, scientists, farmers, students, and sociologists. Such publications are not fully utilized because of inadequate bibliographic access. Mathews notes that only one source is devoted entirely to these documents: *List of Bulletins of the Agricultural Experiment Stations in the United States from their Establishment to the End of 1920* and *Supplements, 1875-1942*. The NAL's AGRICOLA database indexes these documents from 1970 to present, but a number of sources must be consulted to cover the years from 1943 to 1969. Mathews makes the case for a retrospective index with updating supplements to index the entire collection of these important but underutilized documents.

Thomas, S. E. (1988). A coordinated program for state agricultural publications. *College and Research Libraries, 49*(7), 425-430.

Thomas describes a program initiated by NAL in 1984 to catalog and provide access to state agricultural documents. Land-grant university libraries in each state collect and catalog their state's agricultural publications. A copy of each publication with its cataloging is sent to NAL. NAL adds AGRICOLA category codes and other information, such as the NAL call number, and inputs the record into the AGRICOLA database. Records also are sent by NAL to FAO's (Food and Agriculture Organization of the United Nations) AGRIS (the International Information System for the Agricultural Sciences and Technology) database. Patron requests for this material are directed to the land-grant university. This cooperative project has resulted in other state agricultural document projects. Thomas briefly describes some of these projects including the University of Illinois Agriculture Library's retrospective analytics project for USDA documents dating from 1862.

Reference Service Trends

André, P. Q. J. (1989). Optical disk applications in libraries. *Library Trends, 37*(3), 326-342.

André discusses the application of three major types of optical media that are in use in U.S. libraries today: CD-ROM, digital videodisc, and WORM (Write Once Read Many). The use of these technologies in the three national libraries and various academic and public libraries is highlighted. These three optical disc technologies will continue to play an increasingly important role in the way libraries deliver information. This is a detailed current examination of the use of these technologies in selected U.S. libraries.

Frank, R. C. (1987). Agricultural information systems and services. *Annual Review of Information Science and Technology, 22,* 293-334.

Frank covers most aspects of agricultural information systems and services in this concise but wide-ranging examination. Provides a brief history of agricultural information in the United States and background information. Various agricultural information user populations are identified, with a table showing individual information needs and information sources to meet those needs. Among the numerous topics covered, Frank reviews bibliographic databases and cites studies that compare and contrast agricultural information in these online databases. Agricultural research project databases such as the USDA's (U.S. Department of Agriculture) Current Research Information System (CRIS) are discussed as well as numeric databases such as the USDA's Feed Composition Data Bank (FCDB). Microcomputer software packages emphasizing food and nutrition and farm applications are examined. A fourteen-page up-to-date bibliography adds to the usefulness of this review.

Hanfman, D. (1989). AquaRef: An expert advisory system for reference support. *The Reference Librarian, 23,* 113-133.

This paper provides the basic planning and design considerations of an important emerging automated reference tool for agricultural libraries and information centers: the expert system. Hanfman discusses the selection criteria used to select the software shell (1stCLASS, produced by Programs in Motion, Inc., 10 Sycamore Rd., Wayland, MA 01778) on which AquaRef, an expert system used for finding aquaculture information sources, was developed. To determine what information was to be included in the expert system, patron requests at the

Aquaculture Information Center, National Agricultural Library, were reviewed for a two-year period. Topics for inclusion were chosen on a frequency basis. An online user evaluation, written in BASIC, was included for users to respond to following an AquaRef session. The current status and future considerations for expanding and updating the AquaRef expert advisory system are discussed.

Von Seggern, M. (1987). Assessment of reference services. *RQ, 26*(4), 487-496.

This annotated bibliography of publications describes methods and instruments for evaluating library reference services in a variety of settings. The bibliography is divided into three parts: reviews of reference evaluation literature; assessment components, including sections on answering success, accuracy, and quality; cost and task analysis; interview and communication; classification of reference questions; reference collections; staff availability; and the use and nonuse of reference services. Von Seggern's focus is on literature up to 1986. This document should prove useful in determining ways to assess the reference departments of agricultural libraries and information centers.

Waters, S. T. (1986). Answerman, the expert information specialist: An expert system for retrieval of information from library reference books. *Information Technology and Libraries, 5*(3), 204-212.

Waters discusses the criteria that were used for choosing the expert system shell, 1st CLASS, for development of Answerman, the National Agricultural Library's demonstration expert system. With 1st CLASS, the system developer uses four screens in defining the system—filing system, definitions, examples, and solutions. To expand the system's capabilities, Answerman was linked to Superindex in BRS, the AGRICOLA database (using either Dialog or BRS), "a BRS database containing the full-text of eighteen American Chemical Society journals" (p. 209), and to a CD-ROM bibliographic reference file. Waters offers thoughts on the future development of expert systems and the linking of these systems to mass-storage devices as well as offering insights into the use of these systems by reference librarians and information specialists.

Document Delivery

Bellamy, M. (1988). Bridging the information gap in African agriculture: CABI's African Agricultural Literature Service. *Interlending & Document Supply, 16*(2), 46-50.

Access to source documents is very important for agricultural research scientists. Bellamy describes a two-year pilot project, begun in 1987, to supply documents to CAB International member countries in Africa. Bellamy provides background information on the development of this pilot project, noting that the East African Literature Service—a table of contents and photocopying service—was the inspiration behind the initiation of this project. Each of the twelve participating countries could select institutions to take part in the project. The thirty institutions chosen were requested to choose four current research topics of interest. SDI (selective dissemination of information) profiles were set up based on these topics and monthly reference printouts were sent to the institutions. Participating institutions could request thirty documents per year for each research profile. The initial evaluation of the pilot project showed that there was little feedback on the document service and on the SDI profiles. Bellamy discusses the future of the pilot project in light of this evaluation.

Brown, S. A. (1986). *Final report of the National Agricultural Library telefacsimile evaluation project.* Beltsville, MD: National Agricultural Library. 117p.

This study, which took place from September 1985 to January 1986, was sponsored by the National Agricultural Library. It involved five Agricultural Research Service libraries, seven land-grant university libraries, and the NAL. Four main areas of document telefacsimile were examined: equipment used, speed of delivery, print quality, and cost. The results showed that print quality was the most significant problem in the use of current (1985) telefacsimile equipment. The overall recommendation from the study was "that the option of text supply over telefacsimile equipment be available when requested by the researcher, but in normal cases the documents be delivered by traditional delivery mechanisms..." (p. 54). This work is an important study of document delivery using telefacsimile not only for the resulting evaluation but for the evaluation methodology employed.

Currie, J. (1985). Document delivery: A study of different sources. In *Information for food* [8 microfiche] (proceedings of the VI World Congress of the International Association of Agricultural Librarians and Documentalists, Ottawa, June 2-6) (pp. 1-13). Ottawa: International Development Research Centre.

This study, done at the Albert Mann Library, Cornell University, from September 1984 to March 1985, examined various document delivery systems in relation to time of delivery and handling costs. The two objectives of the study were "to test whether commercial document services can provide documents more quickly and/or more inexpensively than traditional library sources" (p. 3). "To provide a basis for reviewing the internal procedures in verifying and submitting requests for off campus documents" (p. 3). Each of 124 interlibrary loan periodical requests (publication date after 1975) were sent to three document sources: a publication-specific source, a commercial brokering source, and a traditional library source (using an RLIN or ALA form). The overall results showed that "the use of RLIN and other library sources is about as fast as, and less expensive than commercial suppliers" (p. 11). Based on the results of the study, a proposed model was recommended for obtaining documents from various sources.

Eswara Reddy, D. B. (1987). Information services and document delivery in food and agriculture, in India. *IAALD Quarterly Bulletin, 32*(1), 31-37.

Reddy offers an overview of India's agricultural university and research institute libraries with a focus on document delivery statistics. Data are presented on document delivery orders that were registered and serviced in Delhi during 1983-1984. Information includes time to deliver, procurement sources, and requested document types analyzed by broad subject area and publication year. The collection of, and access to, such data is of importance to agricultural library personnel charged with planning and coordinating document delivery activities in both the developing and the developed world.

Wood, D. N. (1988). Document supply with particular reference to agriculture. *IAALD Quarterly Bulletin, 33*(4), 145-153.

Wood provides a broad overview of the worldwide document delivery services in the field of agriculture, focusing on various national, international, and private sector services, including AGLINET, the British Library Document Supply Centre (BLDSC); UMI (University Microfilms International); and CABI. Wood then examines major areas of importance to document delivery services—new technology, postal services, payment, copyright, and grey literature. A table shows the percentage of total agricultural grey literature records present in seven major online databases. This document will prove useful in alerting agricultural information personnel to the wide range of document delivery services available and current issues facing these services.

Issues for Developing Countries

Broadbent, K. P. (1977). Agricultural information services in developed countries and their contribution to agricultural research. In *Proceedings [of] scientific literature service workshop* (11-13 April 1977) (pp. 8-23). Paranaque, Rizal, Philippines: Philippine Council for Agriculture and Resources Research with the Agricultural Libraries Association of the Philippines.

Broadbent reviews the development of existing agricultural information services in developed countries, examining the role that agricultural information will play in the future "in the context of the total international research effort" (p. 8). Agricultural user populations are identified as well as the mechanisms currently in place to meet their information needs. Broadbent concludes that there is a continuing need for the coordination and cooperation of national information systems if the agricultural information needs of developing countries are to be met.

Cooney, S.; Kaiyare, D. N.; Mbwana, S. S.; Lumande, E.; Cunada, D. S.; Thompson, D.; & Harris, S. C. (1988). Information for agricultural development: The role of literature services. *IAALD Quarterly Bulletin, 33*(2), 79-86.

A literature service, as defined here, makes periodical literature in a main library available to "geographically dispersed user centers" (p.

79). The authors point out that, for developing countries, it is very important for trained technologists to meet and exchange information with colleagues abroad. It is also important for these technologists to have ready access to scientific journal literature. Cooney et al. characterize a good literature service as one which maintains a high level of quality and a wide-ranging literature base and makes this literature accessible to users in a cost-effective and timely manner. The article includes a brief discussion on some successful literature services.

Durrani, S. (1987). Agricultural information services in Kenya and Third World needs. *Journal of Librarianship, 19,* 108-120.

Durrani examines the present status of agricultural information in the developing world with a focus on Kenya and offers solutions to the many problems which still exist. Based on this analysis, relevant usable information currently is not reaching the people that can best benefit from it—i.e., rural people and urban farmers. What is needed is an agricultural information system that addresses the needs of these people. To accomplish this, agricultural information personnel need appropriate training, including a basic agricultural course as well as a course on the social conditions facing the people they will serve. Educational admission requirements for those who want to become agricultural information officers should not exclude individuals who are committed, hardworking, and have practical experience but who do not have the requisite academic background. Collection management practices should reflect the needs of the target population and information should be in the target population's own language. Information should be disseminated through communication, connoting an exchange of information rather than a transmission which usually means one-way communication. The importance of both oral and nonprint forms of information delivery must be recognized. Durrani makes the point that advanced information technology does not always work to the benefit of the people that it is to serve. This is an important document both in terms of stating the problem of information service in developing countries and in offering concrete solutions.

Griffiths, J. M., & Kinney, J. (1985). *Agricultural information needs and services to developing countries.* Rockville, MD: King Research, Inc.

This is a background document used in the development of a memorandum of understanding between the U.S. Agency for International Development (USAID) and the National Agricultural Library (NAL) to explore ways of improving agricultural information services to scientists in developing countries and to the staff of USAID missions. Currently available sources of agricultural information are reviewed with an emphasis on U.S. government services. Coverage includes databases, current awareness and document delivery services, and reference and other information services. Five main recommendations are made: (1) creation of an international agricultural liaison for information systems positions; (2) closer integration of USAID project services with NAL's existing and planned services; (3) investigation of new document delivery systems; (4) exploration of laser disc technology for the distribution of agricultural information; and (5) investigation of the use of telefacsimile for transmitting documents from microfiche to optimize delivery and storage as well as evaluating microfiche versus electronic storage systems.

Kaniki, A. M. (1988). Agricultural information services in less developed countries. *International Library Review, 20*(3), 321-336.

The article provides an in-depth literature review of the development of agricultural information services in developing countries over the last twenty years and discusses recurrent problems and issues. Based on this extensive review, Kaniki determines that there is a lack of literature in this subject area that is based on empirical studies. Because agriculture is such an integral part of developing countries, there is a great need for agricultural information for use in planning and implementing agricultural projects. Problems and issues in agricultural information services facing developing countries include: shortages of qualified personnel; training and status of these personnel; bibliographic control, retrieval, and storage of information; language and illiteracy barriers; and budgetary constraints. Solutions to some of these problems include marketing the information that is available and strengthening the position of agricultural information services in a country's infrastructure.

Kaungamno, E. E. (1979). Information for agricultural development (paper presented at the Agricultural [Crop and Livestock] Research Workshop, Arusha, Tanzania, February 26 to March 3, 1979) (Ocassional Papers [Tanzania Library Services] No. 6) 35p. 33 leaves. (ERIC Document Reproduction Service No. ED 220 076).

This paper is a blueprint for the agricultural information needs of developing countries. Although presented eleven years ago, the agricultural information concerns and problems faced by developing countries as expressed by Kaungamno are still valid. Coordination at all levels is still the key for solving these problems. A detailed checklist of the information infrastructure is presented to allow those concerned with agricultural information planning to assess their performance and needs.

Namponya, C. R. (1986). Agricultural development and library services. *International Library Review, 18,* 267-274.

This paper emphasizes the role of the extension worker in the dissemination of information in developing countries. The delivery of information to the extension worker must be improved if these workers are to communicate information to those who need it. Library staff should determine how extension workers currently collect information for dissemination and identify extension worker information needs and problems they encounter in fulfilling their job requirements. One library should be designated as a depository for agriculturally related documents, and information should be disseminated in the form of summaries or abstracts. Because of the major problem of illiteracy in the developing world, information must be disseminated in both print and nonprint form. Namponya notes that the services that libraries develop for the dissemination of information should be coordinated with functional literacy projects.

Schenck-Hamlin, D., & George, P. F. (1986). Using special libraries to interface with developing country clientele. *Special Libraries, 77*(2), 80-89.

Schenck-Hamlin and George first examine the information needs of developing countries with examples from Egypt, Honduras, and Pakistan. Their main focus is on two special libraries in the United States and how these libraries service the information needs of clientele in developing countries. The Postharvest Documentation Service (PHDS) at Kansas State University, Manhattan, was founded in 1979. As a component of the Food and Feed Grain Institute, the PHDS works closely with overseas projects and training programs that determine and respond to information needs. Documents are acquired by PHDS and their availability is made known to clients through a bi-monthly acquisitions list. The PHDS maintains SDI profiles to inform clients of relevant materials. The Postharvest Institute for Perishables Information Center (PIPIC) at the University of Idaho, Moscow, relies heavily on clients to define their information needs. Clients are queried annually by PIPIC to determine satisfaction levels and to solicit suggestions on service improvements. Both of these services offer innovative methods of making documents available to developing countries via specialized libraries in developed countries.

Thorpe, P. (1982). Agricultural information services for the Third World: Problems, developments and prospects. *International Information, Communication and Education, 1*(2), 159-169.

Thorpe discusses agricultural information problems that face developing countries, including lack of trained personnel, poor communication, lack of physical and financial resources, and organizational structures that lead to duplication of effort in providing services. Although the paper is eight years old, the problems that Thorpe discusses are still inherent in the delivery of agricultural information within developing countries. The role of information services in developing countries is discussed with numerous examples cited. An important feature of this paper is an extensive literature-cited section that provides access to other publications concerning the problems that Thorpe discusses.

TECHNOLOGY

André, P. Q. J., & Eaton, N. L. (1988). National Agricultural Text Digitizing Project. *Library Hi Tech, 6*(3), 61-66.

André and Eaton describe a project initiated by NAL in conjunction with forty-two U.S. land-grant college libraries to test full-text and image digitization of selected databases using CD-ROM as the medium. The purpose of the project was "to determine whether it is now possible to provide in-depth access to the literature of agriculture while at the same time preserving it from rapid deterioration by utilizing the latest in scanning and recognition technology" (p. 62). This project has three phases: the pilot project test of three (possibly four) CD-ROM databases utilizing different software retrieval packages; the evaluation of the pilot project and testing of a CD-ROM database on acid rain literature using the most effective search software from phase one; and an assessment of state-of-the-art transmission of full text via telecommunications. Issues in project implementation are examined. This project will have far reaching implications for the storage and retrieval of agricultural information.

Congressional Research Service. (1983). *Information technology for agricultural America* (prepared for the Subcommittee on Department Operations, Research, and Foreign Agriculture of the Committee on Agriculture. U.S. House of Representatives). Washington, DC: USGPO. 358p.

This report reviews the utilization of computer and telecommunications technology in relation to agricultural information. It identifies the information requirements in the U.S. agricultural community and examines both public and private information systems that are in place to meet these needs. The report examines the role of information technology in agriculture, looking at the past and the present, and assesses information options for the future. Testimony is given from both the public and private sector on present-day needs and priorities for agricultural information handling in the future. Various computerized agricultural information systems are discussed. A brief but useful bibliography is appended. This report is invaluable for those planning computerized information systems and delivering this information to the agricultural community.

Demas, S.; Chiang, K. S.; Ochs, M. A.; & Curtis, H. (1985). Developing and organizing collections of computer-readable information in an agriculture library. In *Information for food* [8 microfiche] (proceedings of the VI World Conference of the International Association of Agricultural Librarians and Documentalists, Ottawa, June 2-6) (pp. 1-16). Ottawa: International Development Research Centre.

This is a detailed overview of policy issues and other considerations for establishing microcomputer centers in agricultural libraries. Although the focus is on one such center—the Microcomputer Center and Software Library at the Albert Mann Library, Cornell University—the detailed outline of collection development and cataloging policies and user services make this document an important blueprint for the development of other such centers. Topics discussed include identifying the library's user populations and the integration of software (computer-readable formats) catalog records into the main library catalog. Related instructional activities at the Cornell center are also covered.

Treitz, W. (1987). *Transfer of agricultural technologies by new forms of conveying information.* Wageningen: Technical Centre for Agricultural and Rural Cooperation. 18p. + 2 tables.

Treitz examines agricultural technology transfer in developing countries, focusing on various electronic technologies for dissemination of professional literature and other information. Technologies discussed include online data banks and optical discs with a detailed examination of the use of CD-ROM technology. Treitz notes that CD-ROM "should have the most promising future for the transmission of scientific information of all kinds in and between developing countries" (p. 12). CD-ROM technology can be used in building data banks of both bibliographic information and nonbibliographic data. The joint CTA/CIMMYT project (Technical Centre for Agricultural and Rural Cooperation, Wageningen and International Maize and Wheat Improvement Center, Mexico) to disseminate plant breeding data on CD-ROM is discussed. Throughout this document Treitz details issues facing developing countries in adopting electronic information transfer.

Van Hartevelt, J. H. W. (1987). Advantages of CD-ROM for local access to computerized databases in developing countries, in comparison with traditional bibliographic services: Suggested pilot projects. *IAALD Quarterly Bulletin, 32*(3), 161-168.

Van Hartevelt notes that developing countries, in many cases, lack facilities to access agricultural information that could be of significant use to them. An overview of current telecommunications facilities in developing countries is presented. Because of (in many cases) limited telecommunications facilities and the prohibitive costs involved in using these facilities for information retrieval, CD-ROM technology could be effectively utilized to increase the accessibility of needed literature and increase the "information self-sufficiency" (p. 162) of these countries. Van Hartevelt suggests CD-ROM pilot projects in sub-Saharan Africa using the *Abstracts of Tropical Agriculture* produced by the Royal Tropical Institute, The Netherlands. CD-ROM technology has the advantage of packaging a large amount of information on a single disc and the use of CD-ROMs eliminates online charges, thus allowing a searcher to be concerned with the search rather than the time spent online. These CD-ROM pilot projects, which would cost less than $1 million (U.S.) to initiate, would include discs with citations, abstracts, and the full text of papers from journals produced in the developing countries. Overcoming copyright restrictions for inclusion of full-text papers is discussed.

Williams, M. E., & Robins, C. G. (1985). *Agricultural databases directory* (Bibliographies and literature of agriculture no. 42). Beltsville, MD: United States Department of Agriculture. National Agricultural Library, 229p.

This worldwide directory of agricultural databases, containing 428 entries, is divided into two sections: word-oriented databases (such as bibliographic, full text, and directories) and numeric databases. The criteria for inclusion of a database in this directory were that the database be computer-readable, publicly available, and related to agriculture. Entries are listed alphabetically within the two sections. Each database record has five elements: (1) basic information including, but not limited to, producer, update frequency, time period covered, language, online vendor, and corresponding print equivalent; (2) subject matter and scope; (3) how the individual database records are indexed, coded, and/or classified; (4) the field elements usually present in an individual database record; and (5) user aids. Indexes to database name, subject, producer, processor, and commercial database name are included. Although five years old, this is still an excellent and useful directory for the agricultural information specialist to use to find information about the variety of databases available for the agricultural community.

MANAGEMENT

Busch, L., & Lacy, W. B. (1983). *Science, agriculture, and the politics of research* (Westview special studies in agriculture science and policy, rural studies series of the Rural Sociological Society). Boulder, CO: Westview Press, 303p.

This is an important volume for those involved in collection development activities in an agricultural library. The 1983 Cornell University study of public service and agricultural faculty focused on the importance of knowing how agricultural scientists use the library for their research. This book covers the research element in detail, describing the U.S. agricultural research system, its structure, and "the many factors that influence the choices of research problems by agricultural scientists working within it" (preface). Chapters include discussions on disciplinary, organizational, and extra-organizational influences on agricultural research, scientific communication, and policy implications. A twenty-five page reference list provides the reader with further information on the subjects discussed.

Deshmukh, G. R. (1987). I.C.A.R. Institute libraries: A survey. *Annals of Library Science and Documentation, 34*(4), 131-148.

A questionnaire was sent to the Indian Council of Agricultural Research (ICAR) Institute libraries concerning their resources, facilities, services, staffing levels, and material acquisitions. Of the thirty-eight questionnaires sent, twenty-nine research institutes responded to the survey (76.3 percent). The complete questionnaire is published along with all responses received, with each library's response identified. This could be a useful management survey instrument for other national agricultural library systems. Based on the results of the survey, Deshmukh recommends that: (1) ICAR develop a written statement of its function, administration, objectives, and policies; (2) lending policies of institute libraries should be liberalized; (3) the Indian Agricultural Research Institute Library in New Delhi should become a depository for Indian agricultural publications and a clearinghouse for dissertations, bibliographies, translations, and agricultural publications; and (4) librarians have a major role in collection development activities.

Olsen, W. C. (1979). Management in agricultural research libraries: The next thirty years. In A. Fusonie & L. Moran (Eds.), *International agricultural librarianship [:] Continuity and change* (proceedings of an international symposium held at the National Agricultural Library, 4 November 1977) (pp. 113-19). Westport, CT: Greenwood Press.

Olsen identifies six factors that continue to influence the management of agricultural research libraries: (1) the trend toward centralization of college and university departmental libraries with the result that agricultural libraries are becoming part of general science libraries; (2) budgetary considerations; (3) lower level administrators becoming more involved in decision-making; (4) information becoming a marketable commodity; (5) technological advances in automation; and (6) clientele needs. Olsen sees the growth of those commercial services that are involved in providing access to and dissemination of agricultural information. With the disappearance of labor-intensive tasks brought about by automation, agricultural research library personnel will become more specialized. The decentralization of specialized libraries will initiate a growth in small agricultural information centers. The use of scientific management techniques will increase, along with the use of evaluations using quantitative measures to assess library effectiveness.

Sattar, A. (1984). Information-seeking behavior of agricultural extension specialists: Its impact on the management of information services. In A. Van Der Laan & A. A. Winters (Eds.), *The use of information in a changing world* (proceedings of the forty-second FID congress, The Hague, Netherlands, 24-27 September) (FID Publication 631) (pp. 299-310). Amsterdam: North-Holland. 469p.

Knowing how patrons search for information is important in library management decision-making. Sattar conducted a study of Illinois extension specialists "to investigate how extension workers search for information, what channels of communication they prefer, what information sources they use, and what their informal communication patterns are" (p. 299). After an extensive analysis of the literature on information use by extension workers, Sattar determined that past studies have focused on opinion rather than actual data about information sources used to answer a specific question. This study uses a methodology based on a critical incident technique where extension workers were asked to describe their last information search. Results show dramatic differences between those sources believed by extension workers to be most useful and those they actually consult. Sattar recommends in-service education for extension workers focusing on library use and familiarizing extension workers with useful and available indexes, abstracts, databases, and literature search options and personal literature filing systems.

AGRICULTURAL INFORMATION NETWORKS

Broadbent, K. P. (1989). *Networking in agricultural information: Needs, possibilities and methodologies-a donors' view* (paper presented at the Second CGIAR Documentation and Information Services Meeting, 16-20 January 1989). ICRISAT, Patancheru, AP, India. 19p.

Broadbent discusses agricultural information networks, focusing on specific networks and reasons for their success. Principles are defined which contribute to a network's success, including many of the same principles outlined by Plucknett and Smith (see later citation). This document is important because it presents a methodological framework for creating and sustaining an agricultural information network which includes the use of indigenous knowledge and the creation of an effective infrastructure.

Eres, B. K., & Bivins Noerr, K. T. (1985). Access to primary and secondary literature from peripheral or less developed countries. *Journal of the American Society for Information Science, 36*(3), 184-191.

The authors performed a regression analysis on journals, abstracting and indexing subscriptions, scientific population size, and number of libraries in developing countries. The resulting analysis showed that there is "a strong relationship...between subscriptions and the size of the scientific population and number of libraries..." (p. 184). The article continues with a discussion of the difficulties that are faced by scientists in developing countries in becoming aware of and using agricultural literature (both primary and secondary sources): the authors offer two networking proposals—proposals that are not meant to be solutions to the problems encountered by scientists but are meant to lay a groundwork for discussion. One network is for regions that have reasonable telecommunications and computer capabilities and is built around a central host computer. The second network is for those regions with less developed telecommunications and computing capabilities and "consists of one or more microcomputers..." (p. 189). This network emphasizes both formal and informal channels of communication. The design and implementation of these networks is examined.

Hoey, P. O'N. (1985). In-house database services to widespread users over a network. In [Proceedings of the] Ninth international online information meeting (London, 3-5 December) (pp. 211-19). Oxford: Learned Information Ltd. 486p.

Hoey provides a brief description of the United Kingdom's agricultural industry and a detailed examination of the information technology infrastructure at the Ministry of Agriculture, Fisheries and Food. Hardware and software systems as well as in-house database management system services utilized in that infrastructure are discussed. This is an in-depth look at the use of computer technology to meet the agricultural information needs of a large and complex organization.

Mann, E. J. (1986). Past, present, and future developments in the transfer and dissemination of agricultural information: The case for a single, coordinated, world agricultural information system. *IAALD Quarterly Bulletin, 31*(1), 5-9.

In this paper, Mann outlines possible steps to be taken in coordinating the transfer and dissemination of agricultural information. Focusing on the information systems of AGRIS, CABI, and NAL, Mann calls for greater cooperation in the areas of data input, indexing, material selection and abstracting, and organization and management. Mann points out that, in the recent past, efforts at coordination among the three major agricultural information organizations has taken place in such areas as a common thesaurus and nonoverlapping information coverage. However, greater cooperation and coordination of effort are necessary due to economic and marketplace considerations. Advances in information technology should be used "to reach a wider user population in all parts of the world..." (p. 5).

Plucknett, D. L., & Smith, N. J. H. (1984). Networking in international agricultural research. *Science, 225*(4666), 989-993.

Plucknett and Smith provide a brief history of agricultural information networks. They note that, to be successful, a network must adhere to seven principles: a research agenda that is realistic and addresses a clearly defined problem; the problem addressed must be widely shared among participants in the network; network participants must have a strong self-interest; resources should be willingly committed; outside financing for the network must be available; participants should have necessary training and expertise; and the leadership of the network should be strong and effective. The focus of this paper is on two well-known agricultural networks: The International Rice Research Institute (IRRI) in the Philippines and The International Maize and Wheat Improvement Center (CIMMYT) in Mexico.

Other Important Documents

Deshmukh, P. P. (Ed.). (1987). *Information systems for agricultural sciences and technology.* New Delhi: Metropolitan Book Co. 193p.

Although this volume of papers delivered at the first ICAR Summer Institute held in Akola, India, in 1985 is to some extent focused on India and has ramifications for agricultural libraries in the developing world, this document is not listed under the developing world category since it addresses so many topics applicable to agricultural libraries and literature worldwide. Topics covered range from a discussion of agricultural review literature and available abstracts and indexes to computer-based information retrieval systems and the use of computers in agricultural libraries. These papers, all by Indian authors, offer a national perspective on the use, bibliographic control, and dissemination of worldwide agricultural information.

Fusonie, A., & Moran, L. (Eds.). (1979). *International agricultural librarianship [:] Continuity and change* (Proceedings of an international symposium held at the National Agricultural Library, 4 November 1977). Westport, CT: Greenwood Press. 127p.

This book is a result of a symposium on international agricultural librarianship held at the National Agricultural Library in 1977. Topics include the changing nature of agricultural librarianship; the future of international cooperation; and information, research, and innovations in agricultural libraries. One of the most interesting chapters is entitled "Agricultural Libraries and the Spirit of Cooperation: A Continuing Process" by Ana Maria Paz de Erickson. The author discusses the Latin American and Caribbean libraries and national information centers from the late 1960s to the late 1970s. Regional and international cooperation programs, such as the Inter-American Information System for Agricultural Services (AGRINTER) and the Agricultural Information Program for the Central America Isthmus (PIADIC), are discussed in some detail. The papers take the issues of international agricultural librarianship up to the mid- to late 1970s and provide a worthwhile backdrop to the discussion of the present and future status of international agricultural librarianship.

Lancaster, F. W., & Beecher, J. W. (1981). *Agricultural librarianship and documentation as a profession* (Proceedings of the VI World Congress of the International Association of Agricultural Librarians and Documentalists. Manila, 3-7 March 1980) (pp. 197-210). Los Banos, Laguna, Philippines: Agricultural Libraries Association of the Philippines and Agricultural Information Bank for Asia.

Lancaster and Beecher note that agriculture is very much an interdisciplinary science with a diverse literature base. This literature comes in a wide variety of formats and treatments and must be disseminated to a diverse clientele. Focusing on the United States, the authors give a brief overview of the development of agricultural libraries and cooperative ventures in agricultural information sharing. The new and developing information technologies which provide access to the worldwide agricultural literature are changing the nature of both agricultural libraries and the work of librarians. The future will see a deinstitutionalization of libraries and a concurrent re-institutionalization of librarians working directly with clientele. Library school curricula will be required to address this changing role of the agricultural librarian.

Liyai, H. A.; Ayaka, B. N.; & Thomas, R. (Eds.). (1984). *Education and training for agricultural library and information work* (proceedings of the International Conference on Education and Training for Agricultural Library and Information Work. Nairobi, Kenya. 7-12 March 1983). 353p. Organized by the

International Association of Agricultural Librarians and Documentalists, Kenya Library Association, Kenya National Academy for the Advancement of Arts and Sciences.

This document is an international overview of education and training for agricultural library and information work. Twenty-five countries from the developing and the developed world were represented at the conference. Taken together, these papers, along with their literature cited sections, form a database of information on education and training for agricultural library and information work that is unequaled in the agricultural information literature. Session topics at the conference included the current status of education and training, special training programs, the availability and delivery of documents, and user populations and their information needs. Individual papers are on topics ranging from evaluation principles for training programs and training needs to the role of aid organizations and the acquisition of materials.

Swanson, B. E. (Ed.). (1984). *Agricultural extension[:] A reference manual* (2nd ed.). Rome: United Nations, Food and Agriculture Organization. 262p.

This is a basic sourcebook on all phases of worldwide agricultural extension, its history and development, function, and structure. The paper by Lancaster and Sattar, "Information Sources to Strengthen Agricultural Extension and Training," presents a brief review of information sources for agriculture and includes a list of forty important agricultural research centers worldwide. A detailed diagram presents the information transfer cycle in agriculture. The book as a whole, although not directly related to agricultural libraries and information centers, provides the agricultural librarian and information specialist with a wealth of literature on global agricultural extension that could be useful in planning, developing, and implementing an agricultural information center.

Bibliographic Control and Agriculture

SARAH E. THOMAS

ABSTRACT

BIBLIOGRAPHIC CONTROL OF agricultural publications is a complex and costly process. Many key agricultural documents are difficult to catalog because they contain insufficient information about the author, publisher, or other essential bibliographic elements that are needed to describe the item. There is also no single source in which to locate all citations to a particular topic in agriculture. AGRICOLA, AGRIS, and CAB ABSTRACTS are the three major databases that provide journal-article-level analysis of agricultural topics. The overlapping relationships among these databases and their unique features are described. Although the labor to obtain control over the voluminous and expanding numbers of agricultural titles is great, the user is hindered in accessing this material by differing formats, varying vocabularies, and duplicative coverage manifested in the three competing bibliographic databases. Recent efforts by the database producers and others to cooperate to reduce overlap and to standardize vocabulary promise to improve the user's lot immeasurably. New technologies have also brought significant gains in the area of bibliographic control, and developments in automated indexing could make the process of providing bibliographic access and control more productive in the future.

Agriculture continues to be vitally important to global economy and stability. In industrialized nations and in less-developed countries, agriculture occupies a prominent position. Access to information about agricultural successes and failures is key to the furthering of research and development that strengthens the agricultural foundation on which the world community depends.

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Bibliographic control provides a meaningful organization for the vast universe of published literature relating to both applied agriculture and scientific research in the field. Defined by *Harrod's Librarian's Glossary* (1987), bibliographic control is "the creation, development, organization, management and exploitation of records prepared firstly to describe items held in libraries or on databases and secondly to facilitate user access to such items" (p. 71). The challenges facing librarians seeking to impose control over agricultural materials are similar in many respects to those encountered by technical services librarians in general. That is, vast quantities of materials must be described and organized in a fashion that promotes access to the bibliographic item.

Oruma (1984) identified basic problems contributing to existing complexities in agricultural information management. One problem centers on the dichotomy between subsidized government research and private agricultural production. The agricultural documentalist must collect, store, retrieve, and disseminate information for two categories of users in the same subject area. A second problem is the multidisciplinary nature that makes agricultural information almost "unmanageably vast." Agriculture today includes not only traditional agriculture but also biotechnology, environmental sciences, human food and nutrition, rural development and sociology, and many other related subjects. Consequently, the meaning of the term "agricultural literature" has become indefinite and imprecise, leaving information managers a most complex task as they seek to organize bibliographic collections (p. 91).

The process of bibliographic description and analysis is still largely labor intensive. Despite incursions made through automation into the rather tedious process of transcribing data, much of the effort in the creation of the bibliographic record remains manual. Catalogers and indexers of agricultural literature must grapple with the inconsistencies of authors and publishers of documents, often struggling to ascertain responsibility for authorship or to determine who published an item and where or when it was published. If one of the principles of bibliographic control is to bring together all the works by a single individual or entity, what is the cataloger to do with an author whose monograph on fungi is attributed to A. Smith? In a large file, this author's books will be comingled with those created by others of the same surname, making it difficult to trace all publications authored by a given scientist. A similar problem may be found when a government agency changes its name. To provide authoritative access to all material emanating from a single source, librarians must often be detectives and genealogists as they track the history of particular corporate bodies.

Another common problem occurs when a journal changes its name, necessitating links to its previous titles. The ability of the user to identify all relevant material as unified by a particular series or journal can be hampered by inadequate references or access points in the catalog, database, or other bibliographic reference tool. Insufficient bibliographic information contained in the item being cited can thwart description and analysis of a publication and hinder access. Although this deficiency is not unique to agricultural publications, it is probably more common in the sciences than in the humanities, and similarly more likely to occur in publications issued by corporate bodies and government agencies, many of which are important sources of agricultural materials. In addition, Third World nations, with their strong agricultural base, are often valuable resources for agricultural documents, but bibliographic control of publications from most developing countries is notoriously poor because they frequently do not follow standard bibliographic conventions. Thus, bibliographic control of agricultural documents is exacerbated beyond the routine because a greater proportion of the publications in the field is produced by those for whom bibliographic concerns are secondary or even irrelevant. They are often printed on poor quality paper, disseminated informally, limited in quantity, and intended primarily to meet an immediate need. Their long-term value is not always perceived, and rarely do the authors or publishers consider the importance of ensuring that an archival copy be retained. For example, even in the United States, extension service pamphlets are often considered ephemeral, and bibliographic control of these has been lax.

"Grey" or "fugitive" literature comprises a substantial segment of agricultural publications and is difficult to obtain and to manage. Grey literature, or nonconventional literature, is material such as reports that is not distributed through commercial channels. Such literature often is produced in only a few copies and is not sold by its publishers. It is cited infrequently in national bibliographies and is consequently not widely publicized. What the authors and publishers of agricultural literature fail to realize is that the lack of full publication or other bibliographic information impedes the dissemination of the information contained within their publications. Catalogers and indexers must devote scarce resources to unraveling the bibliographic mysteries they encounter, slowing the processing of other materials. Worse yet, they may fail to decipher an important clue and omit a key access point.

In addition to incomplete, inadequate, or confusing information relating to the bibliographic item, there are a number of other factors that complicate bibliographic control. The problems in providing access to agricultural materials are compounded as geographical and political boundaries are crossed. Since agricultural information is of worldwide significance, access to it needs to be as broad as possible. Yet this international demand for agricultural information raises important issues with regard to language of access, format, and even description of content. For example, if a controlled vocabulary is employed, what language is used? Because the primary producers of agricultural databases have been from English-speaking countries, the major thesauri have been published in the English language. Multilingual vocabularies exist but are not applied to all, or even a majority of, bibliographic records. Different countries have developed different conventions and formats for recording bibliographic data, thus hindering exchange and manipulation of data. In the United States, for instance, most research libraries adhere to the *Anglo-American Cataloguing Rules,* second edition, for cataloging monographs, serials, audiovisuals, maps, computer files, and other bibliographic formats. They use the MARC (machine-readable cataloging) format for communicating their cataloging records. In theory, if not entirely in practice, U.S. and British librarians share a common cataloging code and both embrace the MARC format. A number of fairly significant variations make sharing of their data slightly troublesome although far from impossible. Yet there are a number of other points on which practitioners in these two so closely related countries diverge, particularly in the area of classification and subject analysis. Cataloging records created in other countries are even less likely to follow the same convention.

In the United States, almost all research, most public, and many special and school libraries use a bibliographic utility such as OCLC (Online Computer Library Center, Inc.), RLIN (Research Libraries Information Network), or WLN (Western Library Network) for cataloging. These systems are supported by large mainframe computers and provide access to databases containing millions of bibliographic records. Located in Dublin, Ohio, OCLC started as a consortium of Ohio libraries in 1967 and has grown to serve over 6,000 libraries. The OnLine Union Catalog contains records for over 20 million items. RLIN, the operational arm of the Research Libraries Group, based in Mountain View, California, holds records for over 17 million bibliographic items in its database. These records were contributed by thirty-four of the nation's largest research libraries and other special and associate members. The Western Library Network, much smaller than OCLC or RLIN, is the bibliographic support system of choice in the Pacific Northwest. Its database comprises approximately 5.5 million records.

All three databases share several characteristics that are typical of bibliographic control of monographs, serials, maps, audiovisuals, and computer files in North America. First, and above all, they are databases created through shared cataloging endeavors. The Library of Congress (LC) MARC records serve as the foundation for these databases. The MARC Distribution Service of the Library of Congress provides almost 350,000 MARC records annually, and these records are used many times by participating libraries in the production of records or cards for their local catalogs. Cooperating libraries contribute original cataloging for items not represented in the database, and other institutions, in turn, take advantage of this member-contributed copy to reduce their need for original cataloging. The value of such cooperative enterprises is the increase in available bibliographic records and the consequent reduction in the need for expensive, labor-intensive original cataloging (Bengston, 1984; Horney, 1984).

The success of cooperative cataloging has spawned other programs in bibliographic control. One major effort is CONSER, created as the CONversion of SERials and now the Cooperative ONline SERials program. Originally conceived as a project to create machine-readable records for serials through a retrospective conversion project, the program has grown to encompass much more. The database is a widely available source of authoritative bibliographic information about serials. At the end of 1988, it contained 437,623 records with 46,274 records added or newly authenticated during 1988. The National Agricultural Library is a CONSER participant specializing in providing bibliographic control of agricultural serial publications.

Another key bibliographic program is NACO (Name Authority COoperative Project). It was initiated in 1979 and is now known as the NAtional Coordinated Cataloging Operations. Participants contribute headings to a cooperative automated name authority file. Authority control is a vital aspect of bibliographic control particularly when libraries contribute records to large network databases. An authority file is a record of the authorized or established forms of headings or access points used in the catalog (Bengston, 1984). Without adherence to authorized headings, conflicts result and the user of a catalog or database may not locate all items relating to a particular subject or created by a specific individual or corporate body. NAL is a participant in NACO and contributes authoritative forms of names in the field of agriculture.

In agricultural literature, however, cataloging records represent a minority of items under bibliographic control. Indexing records comprise 85 percent or more of the large agricultural databases, underscoring the importance of journal literature in scientific disciplines. Database producers do not follow a single common standard; consequently, there are salient differences in the methods for describing bibliographic items. Journal title abbreviations vary, different elements are recorded, and the formats in which they are created differ markedly. Furthermore, while a tradition of sharing cataloging records has been established in the United States and is gaining strength internationally, no such model exists for indexing. This movement has led to increased standardization to facilitate the exchange of cataloging records. In the past decade there have been some attempts at increased cooperation in indexing, but the union catalog that exists for monographs has not materialized for journal articles. Most U.S. research libraries contribute records for monographs and other materials to OCLC or RLIN, but BIOSIS, Chemical Abstracts, CAB ABSTRACTS, and AGRICOLA (AGRICulture OnLine Access) records all employ varying formats, and their producers generally do not exchange or share records, a situation dictated by commercial considerations as well as technical issues. AGRICOLA records for U.S. imprints are shared with AGRIS (The

International System of the Agricultural Sciences and Technology), but they are subjected to several machine and human edits because of varying policies, procedures, and formats, and thus the transfer of records is not accomplished seamlessly as it is in the North American model for the creation and exchange of cataloging data.

Bibliographic control, as practiced in the creation of databases of citations to agricultural publications, has several other critical characteristics beyond the standards used for bibliographic description and analysis and the formats used to describe this content. One of the key factors in the management of the data is the extent of coverage. The enormous quantity of publications being issued means that essentially no single library or institution can afford to collect comprehensively in all aspects of agricultural literature and has provided the impetus for cooperative collection development. Similarly, no library possesses the resources to catalog or index all material being published in agriculture and relevant sciences. Arrearages, and how best to handle them, is a frequent topic of discussion among technical services librarians and ample testimony to the magnitude of the problem. Librarians have developed several strategies for coping with an almost unmanageable volume of publications. One method is to be highly selective about the titles one acquires, catalogs, or indexes. Another approach is to catalog or index more material but with a less than full record. Subject analysis may be omitted or curtailed. A third tactic is to work cooperatively with other libraries or documentation centers to create a shared database, distributing responsibility for bibliographic control. Many institutions employ a combination of these methods according to the priorities established for processing their acquisitions. They catalog or index core material fully but treat peripheral material less completely. Core journals may be indexed cover to cover, while other publications less central to the needs of the database's users will be analyzed selectively. Certain ephemeral materials may not be recorded at all. Domestic titles may be accorded a higher priority than foreign publications, or documents detailing research activities may be processed before popular reading material intended for the lay person. The priorities naturally reflect the mission of the institution.

Processing priorities determine the timeliness of the data available to the public or database user and are thus an important element in the management of the database. Different disciplines have differing perceptions of the necessity for timely data, with the medical and scientific professions placing a premium on very recent information, and humanistic areas more tolerant of a longer delay between appearance of a title and its citation. Much scientific information is presented at conferences and published in proceedings that are in high demand in the field of agriculture. Other scientific findings and research results appear in journal articles, which are more rapidly written, reviewed, and published than monographs. When time is of the essence for publication and dissemination of results, timely citation of those results is equally important. Several studies document the length of time between publication of a document and appearance of a citation to that document in a major database, with the implication that a faster turnaround contributes to a higher quality, more valuable database.

Another policy decision affecting the utility of a database relates to the inclusion of abstracts. If a citation also includes an abstract, the researcher may be able to determine if the full text is required. Elimination of unnecessary requests for copies of journal articles or other library materials conserves the lending institution's resources and allows the user to spend his or her time more productively. On the other hand, incorporation of abstracts into the bibliographic record is an expensive process. Merely keying in the author's abstract, once the publisher's permission has been obtained for copyrighted materials, is costly. The creation of original analytical abstracts is obviously more costly. Thus the value of the abstract to the user must be weighed against the expense of inclusion, and the resulting equation must take into account the ultimate cost of using the database vis-à-vis its value to the user.

There are a number of sources that seek to organize publications relating to agriculture in formats that provide constructive access to the information they contain. Figuring prominently among these sources are three large agricultural databases that collectively index over 11,600 agricultural journals and provide access to hundreds of monographs, technical reports, and other materials annually. The three databases providing the most concentrated and comprehensive focus on agricultural literature are: AGRICOLA, generated by the staff of the National Agricultural Library of the U.S. Department of Agriculture (USDA); AGRIS, the database created through the cooperative efforts of those working through the Food and Agriculture Organization (FAO) of the United Nations; and CAB ABSTRACTS, the product of CAB International (CABI).

Several other databases offer access to literature of interest to agricultural researchers, but their focus is either more general or more narrow. For example, citations included in BIOSIS or CA Search often overlap with those in AGRICOLA, AGRIS, and CAB ABSTRACTS, but these databases also contain many other references that are irrelevant to agricultural study. Other bibliographies or databases may cover one topic in depth, such as a particular crop, but they do not attempt to index the whole of agricultural literature. Agriculture covers a broad spectrum of subjects and may include topics related to medicine and the biological sciences, science and technology, and energy and the environment. Among some of the more frequently consulted databases other than those named earlier are Aquatic Sciences and Fisheries Abstracts; CRIS (Current Research Information System); Food Science and Technology Abstracts; MEDLINE; GPO (Government Publications Office); NTIS (National Technical Information Services); PREDICASTS; and the Dun and Bradstreet family of databases. Such databases provide access to literature that may be essential for the agricultural researcher or administrator but that may not fall into the scope of AGRICOLA, AGRIS, or CAB ABSTRACTS. In general, however, the three major agricultural databases are the best resources for most topics relating to agriculture. Each of these databases has a unique slant; consequently, they must be seen as complementary rather than duplicative.

The National Agricultural Library initiated what became known as AGRICOLA in 1970. CAIN (Cataloging And INdexing system of the National Agricultural Library), as the file originally was called, included citations to journal articles, book chapters, conference proceedings, monographs, microfilms, patents, theses, and other items cataloged or indexed by NAL in machine-readable form. When NAL began issuing machine-readable tapes of its cataloging and indexing records in the MARC format in 1976 to conform to U.S. library standards calling for output using MARC, the database was renamed AGRICOLA. Throughout the years AGRICOLA has undergone numerous changes, reflecting shifting priorities within USDA, new directions in agriculture, and response to user needs. These changes—made to improve the database—have also resulted in inconsistencies in structure and content. Before 1987, for example, AGRICOLA included material in several subfiles such as AGECON (Agricultural Economics-USA) and FNC (Food and Nutrition). AGECON contained records with abstracts contributed by the American Agricultural Economics Documentation Center of the USDA Economic Research Service. When support provided through the American Agricultural Economics Association ceased in 1986, NAL assumed responsibility for indexing core agricultural economics literature, albeit without abstracts, and added these records to the main file rather than to the subfile. In general, the trend in AGRICOLA has been toward the discontinuation of separate subfiles in favor of a single integrated database with enhanced access that offers the capacity for creating subsets through retrieval techniques rather than the creation and maintenance of separate subfiles. Some other historical subfiles in AGRICOLA are: brucellosis, environmental impact statements, 4-H publications, adult extension, and parasitology. The FNC subfile, representing titles selected by the Food and Nutrition Information Center of the National Agricultural Library, is an ongoing subfile distinguished by its subject focus and by the fact that each record in it also contains an abstract or annotation.

All records in AGRICOLA are accessible through subject category codes which provide broad topical access. These codes, which have undergone three changes since their introduction, carry a numeric or (currently) alphanumeric notation. Since indexing and cataloging records in AGRICOLA employ different controlled vocabularies, the category code is the single unifying access point at the subject level.

Monographs and other cataloged material constitute 16 percent of the 2.6 million records in the AGRICOLA database. Prior to July 1972, these records carried subject headings from the *National Agricultural Library Subject Heading List*. Since that date, Library of Congress subject headings (LCSH) have been employed. Before 1985, a controlled vocabulary for indexing records, which constitute 84 percent of the database, was not used except in the case of the FNC subfile. Subject access to the majority of records was available through the AGRICOLA category codes and through keyword (free-text) searching, which provided inconsistent and uncertain results depending on the adequacy of titles to represent article contents and of searchers to formulate effective search strategies. Recognizing this deficiency, NAL evaluated options for controlled vocabularies and in 1984 selected the *CAB Thesaurus*.

The *CAB Thesaurus* prevailed as the working tool of preference because of its extensive research-oriented vocabulary of over 48,000 terms and because CAB International, then Commonwealth Agricultural Bureaux, agreed to modify the second and subsequent editions of the thesaurus to reflect AGRICOLA indexing requirements. As a result of this agreement between CAB International and NAL, the second edition of the *CAB Thesaurus* was annotated to incorporate the so-called "Americanisms"—those terms or spellings used commonly in the United States. For example, the British "groundnuts" was supplemented by the American "peanuts," and "flavour" by "flavor." In addition, NAL indexers recommended new terminology for inclusion in the thesaurus to accommodate AGRICOLA's scope and coverage or to represent new concepts in agriculture.

Overall, the effect of the use of the controlled vocabulary has been the imposition of greater consistency on the indexing records being contributed to the AGRICOLA database. Compared to the practice of title enrichment, which had been followed before the introduction of the *CAB Thesaurus*, the new policy injected a greater rigor into NAL indexing practice, and, consequently, resulted in higher quality indexing records (Thomas, 1985). Indexers apply approximately eight to ten terms per record, providing greater access to the topic being analyzed. As a result of this shift in policy, online searchers and other users of AGRICOLA or the *Bibliography of Agriculture* have benefited. Hood (1988) calculated that use of a controlled vocabulary in searching AGRICOLA results in greater precision in retrieval and decreased costs. In performing an online search in response to a specific reference query, Hood retrieved 274 percent more relevant records when employing *CAB Thesaurus* descriptors than when searching titles and abstracts free text. Furthermore, the cost per relevant record decreased 82 percent in the controlled vocabulary search. Controlled vocabularies are especially useful in controlling synonyms and quasi-synonyms. Hood observed that "a controlled vocabulary facilitates economical searching by shifting costs from output (searching) stage to the input (indexing) stage of information retrieval systems" (Hood, 1988, p. 16). Since NAL implemented use of the *CAB Thesaurus*, over 400,000 items have been indexed using CAB descriptors, creating a large selection of current records with access provided through a controlled vocabulary.

One immediate effect of the transition to a controlled vocabulary was a drop in the number of items indexed from about 120,000 annually to 80,000. Because there were inadequate resources to expand the indexing staff, NAL reduced the number of journals indexed. The pressure to eliminate titles from the list of journals indexed to counter the mounting backlog coincided with a new policy aimed at decreasing the extent of overlap with AGRIS. At the AGRIS Technical Consultation in June 1985 in Rome, Italy, and again at the seventh conference of the International Association of Agricultural Librarians and Documentalists (IAALD) in Ottawa, Canada, in 1985, agricultural information leaders called on the producers of the three most prominent agricultural databases—AGRICOLA, AGRIS, and CAB ABSTRACTS—to cooperate in the coverage of the world's agricultural literature by dividing responsibility for various aspects of agriculture. At the same time, the National Agricultural Library established a policy of eliminating from its coverage foreign language journals included in AGRIS and began encouraging countries participating in AGRIS to increase the extent of their coverage. As a result of this policy, the number of journal titles indexed in AGRICOLA decreased from over 5,000 in 1984 to slightly over 2,500 in 1989. The percentage of U.S. literature indexed in AGRICOLA rose from 29.88 percent to 55.19 percent during the same period as a direct result of NAL's implementation of its stated objective of being the premier source for U.S. publications in the field of agriculture, especially USDA and state agricultural experiment station and extension service documents. Coverage of U.S. literature is actually substantially higher than 55 percent when consideration is given to the number of international publications that have joint places of publication—such as London and New York—but are not counted as U.S. imprints in statistical analysis.

NAL and forty-seven land-grant university libraries have been participating in a program to increase the bibliographic control of state agricultural publications in AGRICOLA (Mathews, 1987, 1988; Thomas, 1988). In this program, each land-grant library assists NAL in identifying and verifying titles published in its state and, in some cases, arranges for the titles to be sent to NAL. If the library catalogs titles appearing in a particular series, it notifies NAL. Catalog copy from the land-grant library is used as the basis for NAL's cataloging record which is entered into AGRICOLA. NAL either catalogs or indexes items not covered by the land grants. As a result of the cooperative activity and increased priority given to processing this material, the AGRICOLA database logged the entry of over 5,800 state agricultural publications in 1988, a 20 percent increase over the number added to the database in 1984, the year the program was initiated. The number of state agricultural publications indexed by NAL rose 85 percent over the same interval, from 2,837 in 1984 to 5,242 in 1988, as NAL increased its coverage of items not cataloged by land grants. In addition, catalogers are attempting to improve bibliographic control of state experiment station and extension service publications, most of which are issued in series, by communicating directly with the originators of the documents. Through a program of education about the requirements and advantages of bibliographic control, the catalogers are endeavoring to reduce the practice of publishers of providing inadequate or ambiguous bibliographic informaiton that frustrates effective bibliographic control.

Retrospective conversion projects and other special cataloging efforts also have enhanced coverage of USDA and state agricultural publications in AGRICOLA. The University of Illinois at Urbana-Champaign Agriculture Library Project has received funding from the U.S. Department of Education to catalog selected USDA and state agricultural experiment station publications. Over the first four years of this project, the University of Illinois has provided access to over 40,000 titles in OCLC and AGRICOLA.

One distinguishing characteristic of AGRICOLA is that it provides holdings information and, in almost all cases, call numbers, allowing the searcher to locate the source of the citation for examination of the full text. For many years, every item cited in AGRICOLA was held by NAL. In 1985, NAL began a cooperative cataloging program in which records are contributed by land-grant university libraries for agricultural titles not held by NAL. This program recognizes the breadth of agricultural collections across the United States and acknowledges that NAL depends—just as other U.S. research libraries do—on resource sharing rather than physical ownership for access to a comprehensive agricultural collection. The decision to permit organizations outside of NAL to enter records into AGRICOLA was a step toward increasing the scope of the database and providing access to more agricultural publications. Accordingly, some universities have begun including records for their doctoral dissertations and master's theses, a category of material not systematically collected by NAL; other institutions supply citations to titles in subject areas in which they maintain the premier collection (Thomas, 1989). Cornell University's Mann Library cataloged extensive Chinese language holdings on agriculture and made these records available for inclusion in AGRICOLA (Acosta, 1989). The AGRICOLA database has been significantly strengthened by these efforts.

AGRICOLA also is notable for its coverage of a variety of formats. In addition to bibliographic records for monographs, serials, and journal articles, AGRICOLA contains references to audiovisual material such as filmstrips, videotapes, slides, photographs, and audiotapes; to computer software and laser discs; to manuscript collections; to maps; to patents; and to realia such as three-dimensional representations intended for instructional purposes. This extensive array of subjects, formats, and types of materials makes bibliographic control of agricultural material in AGRICOLA complex and challenging.

NAL contributes bibliographic records for documents published in the United States to AGRIS, one of the three large agricultural databases. AGRIS, which became operational in 1975, is a cooperative database produced under the auspices of the Food and Agriculture Organization of the United Nations. Over 127 national centers and 18 regional and international centers prepare records for AGRIS with each participating country assuming responsibility for providing bibliographic control over its national production of agricultural publications. AGRIS numbers over 1.5 million references and is growing at an annual rate of about 120,000 records. U.S. records have accounted for 42 percent to almost 50 percent of contributed records in recent years. The German Federal Republic, France, Japan, and the Netherlands are the next largest contributors, with 10 percent, 5 percent, 5 percent, and 4 percent, respectively, of the records coming from these national centers in 1987 (Lebowitz, personal communication, 1988). Although developed countries provide more than two-thirds of the citations, most of the centers preparing records represent developing nations. It is the potential of these less-developed countries to provide access to the agricultural information within their geopolitical boundaries that makes the concept of AGRIS so unique. AGRIS participating centers follow procedures developed in consultation with FAO's AGRIS Coordinating Centre located at FAO headquarters in Rome, Italy. Manual and automated input to the database is handled through the AGRIS Processing Unit at the International Atomic Energy Agency in Vienna, Austria.

It should be noted that the AGRIS database that is marketed in the United States (called AGRIS International) differs from the worldwide edition of AGRIS primarily in that it does not contain records with U.S. imprints which would duplicate records in the AGRICOLA database. Furthermore, all records contributed by NAL are not included in the AGRIS database because AGRIS considers aspects of certain subject areas which are core to AGRICOLA—such as human ecology—to be outside of its scope.

To facilitate access to data in many languages, references are indexed using AGROVOC, a multilingual agricultural thesaurus prepared by FAO in conjunction with the Commission of the European Communities. AGROVOC, first published in 1982, is a thesaurus of approximately 9,000 terms. English, French, German, Italian, and Spanish editions of AGROVOC already exist, and other versions, such as Portuguese, are being developed. The focus of the AGRIS database is on worldwide information in scientific, technical, and socioeconomic publications relating to food and agriculture. In general, the mission of AGRIS is to serve less-developed countries as well as developed nations. The agricultural literature of developing countries, often omitted from databases produced in developed nations, is of particular relevance to agriculturists in other developing countries (Samaha, 1988).

CAB ABSTRACTS, the third major agricultural database, began in 1972 as an outgrowth of CAB printed publications. Produced by CAB International, which is based in Wallingford, Oxon, United Kingdom, CAB ABSTRACTS now contains some 2 million citations covering agriculture, forestry and forest products, and allied disciplines. CABI editors and associates scan over 9,100 serial titles annually, resulting in a yield of about 130,000 references being added to the database each year. Items are selected for indexing on the basis of their research value and their relationship to one of several of CABI's abstract journals. CABI consists of fourteen bureaus and institutes concentrating on a range of subjects from helminthology to forestry and crop science to recreation and leisure. When the Commonwealth Agricultural Bureaux underwent a transformation in the 1980s from being a Commonwealth organization to being an international group, countries outside the British Commonwealth were invited to join the renamed CAB International. An arrangement was made for the Chinese Academy of Agricultural Sciences to contribute indexing records for Chinese agricultural publications. More recently, Hungary has joined the organization, and further non-Commonwealth countries are considering membership. These associations allow CABI to maintain a database rich in foreign language materials. Approximately forty languages are represented in CAB ABSTRACTS. Perhaps the most prominent feature of CAB ABSTRACTS is its reliance on original abstracts created by subject experts on the CABI staff for about 85 percent of the material being cited (Porta, 1986). These lengthy abstracts offer a depth of subject analysis highly valued by users of the database. In addition to the abstracts, subject access is available through the application of *CAB Thesaurus* terms and more general subject codes.

All the earlier mentioned databases share some common elements. AGRICOLA, AGRIS, and CAB ABSTRACTS are all large files providing access to agricultural information and, as such, overlap to some extent. Numerous studies examining the degree of overlap have been conducted over the past decade (Brooks, 1980; Datta, 1988; Frank, 1987; Heise & Hood, 1987; Krabbe, 1979; Longo & Machado, 1981). One of the most recent, conducted under the direction of Norbert Deselaers of the Federal Ministry of Food, Agriculture and Forestry of the Federal Republic of Germany, indicated that, in 1983, there was substantial duplication among the databases. Deselaers (1986) reported a 32.4 percent overlap among the three. Other studies have found from 15 percent to 40 percent overlap. Using data from the World List of Agricultural Serials database at NAL, a comparison of the journal titles indexed in AGRICOLA, AGRIS, and CAB ABSTRACTS reveals that of the 9,190 titles scanned by CABI, 1,178 of them, almost 13 percent, are also indexed in AGRICOLA. AGRIS indexes 1,386, or approximately 15 percent, of titles scanned by CABI. Of those, 728, or 27.7 percent, overlap with titles covered in AGRICOLA. The higher proportion is not surprising since there should be almost a 100 percent overlap of the U.S. titles in AGRIS and AGRICOLA; U.S. indexing constitutes a substantial proportion of AGRIS. With regard to foreign titles indexed in both AGRICOLA and AGRIS, there is virtually no duplication: in 1986, a mere 9 percent of non-U.S. titles indexed in AGRICOLA were duplicated in AGRIS, and in the intervening years, further reductions have been made in this area of coverage. Of the entire list of 11,619 titles, only 450 are indexed in all three databases. Of the 2,510 titles indexed in AGRICOLA, 999 are not indexed by either AGRIS or CAB ABSTRACTS; 1,097 of the 2,816 titles indexed in AGRIS are unique; and 7,076 titles scanned by CABI out of its total list of 9,190 titles are not covered in either AGRICOLA or AGRIS.

Analysis of journal title overlap yields incomplete information. The National Agricultural Library and CABI have approximately the same level of production of bibliographic records, yet CABI scans more than four times as many journals. CABI selects fewer articles from particular journal titles whereas NAL indexes many journals cover to cover. U.S. imprints selected from AGRICOLA for contribution to AGRIS make up over 40 percent of AGRIS records in any given year. Overlap of records not linked to journals is even more difficult to estimate. Deselaers (1986) argued convincingly that "every third documentation unit in the agricultural sector was analyzed unnecessarily" (p. 24), and he estimated that $2.5 million could be saved through an integrated agricultural information system (p. 25). NAL's decision to reduce overlap with AGRIS would change the basis of Deselaers's calculations in 1989, but there is no doubt that substantial savings could be realized through increased cooperation. Not all information scientists, however, regard database duplication as unhealthy or wasteful. Heise and Hood (1987) note that some researchers have demonstrated positive aspects of overlap for database searching. Onorato and Bianchi (1981), for example, identified the following benefits: records for the same items retrieved on different files may contain different information, and every duplicate, therefore, adds unique data; if several databases choose to index the same article, this may be taken as evidence of the value of the article; a retrieval of duplicates may confirm the validity of the search strategy used; the presence of duplicates helps to provide knowledge of areas in which files overlap and may thus support decisions as to which files to search for a particular topic; and comparisons of duplicates advance knowledge of indexing policies of different databases and may thus lead to improved search strategies in these databases. Buckland, Hindle, and Walker (1975) also cited the utility of overlap as a planning parameter. It appears likely that some overlap between and among agricultural databases will continue for the near future despite increased cooperation among the database producers. As each database caters to a slightly different, but also overlapping, audience, the database producers will continue to respond to the needs of their users and to the mission of the larger organizations of which they are a part. Nevertheless, a unified database reflecting all constituencies would be a great boon for agriculturists and database searchers and producers. Considerable economies would be realized through enhanced collaboration in the production of a single comprehensive agricultural database. AGRICOLA, AGRIS, and CAB ABSTRACTS, while all covering some of the same ground, have many points of dissimilarity. Table 1 attempts to identify some prime characteristics of the three databases.

Much has been said about the duplication of effort in establishing bibliographic control over international agricultural publications. Deselaers (1986) contends that one-third of the records in the three major agricultural databases overlap, and that the cost of creating and maintaining these redundant files amounts to millions of dollars. Comprehensive searching necessitates the involvement of three or more files and substantial duplication of citations is encountered; the added cost associated with this activity is clearly undesirable. Ernest Mann, president of the International Association of Agricultural Librarians and Documentalists (Mann, 1986), urged a rethinking of definition of scope for the three major databases in a paper delivered in Ottawa in 1985. He proposed that AGRICOLA concentrate primarily on U.S. literature; AGRIS concentrate on nonconventional and some conventional literature from participating centers; and that CAB cover the "bulk of the world's conventional agricultural literature" (p. 6). Mann envisioned a single, integrated information resource using standardized indexing procedures and a shared indexing language based on a unified thesaurus (p. 8). Realization of this vision remains elusive, but the three major producers of bibliographic records have developed some areas of cooperation that are mutually beneficial and, more importantly, of service to the users of agricultural information.

One key area of cooperation lies in thesaurus building. Unfortunately, when there was a growing recognition of the need for an agricultural vocabulary to offer greater control and access to the increasingly large files of bibliographic records being created, the paths of the database producers diverged. The Commonwealth Agricultural Bureaux developed the *CAB Thesaurus,* a tool tailored to the audience of the CAB abstract journals, rich in terminology and leaning heavily toward the scientific and research side of agriculture. At the same time, AGROVOC was developed for use in indexing for AGRIS but with a different slant. It employed only about one-sixth the terms selected by CAB, choosing a simpler approach that relied on broader terms. AGROVOC too was targeted to a specific audience, one that consisted of a majority of non-native English speakers residing primarily in developing countries. The National Agricultural Library briefly considered generating its own unique agricultural vocabulary, customized to suit

TABLE 1
CHARACTERISTICS OF AGRICOLA, AGRIS AND CAB ABSTRACTS

	AGRICOLA	*AGRIS*	*CAB ABSTRACTS*
Size of database, 1989 (no. of citations)	2.6 million	1.5 million	2 million
Average annual growth (no. of records)	110,000	120,000	130,000
Established	1970	1975	1970
Abstracts	15% (since 1988)	10%	85%
Vocabulary	*CAB Thesaurus* Library of Congress Subject Headings	AGROVOC (English, French Spanish)	*CAB Thesaurus*
No. of languages covered	56	38	48
Citations in English	71%	60%	68%
No. of titles indexed (1989)	2,510	2,816	9,190
Focus	U.S. literature, especially USDA and state agricultural publications	International with special emphasis on developing countries	worldwide research
Producer	USDA, National Agricultural Library	Food and Agriculture Organization of the UN, AGRIS Coordinating Center	CAB International
Availability	Online: BRS DIALOG DIMDI CD-ROM: OCLC SilverPlatter Print: Bibliography of Agriculture	Online: DIALOG (Non-U.S. titles only) IAEA IRS DIMDI CD-ROM: SilverPlatter Print: AGRINDEX	Online: BRS CAN-OLE DIALOG DIMDI ESA-IRS JICST Tsukuba Daigaku CD-ROM: SilverPlatter Print: 27 main journals and 20 specialized journals published by CABI
Updated	Monthly	Monthly	Monthly

its user community but discarded the idea as excessively costly. After reviewing AGROVOC and the *CAB Thesaurus* during 1984, NAL entered into an understanding with CAB to use the *CAB Thesausus* and to participate in the development of a revised version of the thesaurus that would meet most of NAL's requirements. Although a common agricultural vocabulary did not result from the appreciable investment of resources into thesaurus construction, at least searchers could benefit from having two vocabularies to provide access to the citations being added to the databases, and there were only two, not three, variations.

Since the appearance of AGROVOC and *CAB Thesaurus* in 1983, agricultural librarians and documentalists have made progress in bringing these two important resources into closer alignment. The National Agricultural Library has worked with AGRIS to develop tables for converting *CAB Thesaurus* terms to AGROVOC terms, and NAL routinely attends semiannual meetings on AGROVOC revisions in Rome. Proposed changes are carefully checked against CAB terminology, and every effort is made to reduce variation between the two vocabularies. AGRIS leadership "realized that the original restriction of 8,000 descriptors was unworkable, and ...[AGRIS] has been adding new descriptors, particularly for commodities and taxonomic terms..." (Lebowitz, personal communication, July 19, 1989).

Despite these cooperative endeavors, the hard reality remains that two disparate vocabularies are in use in the three large agricultural databases, and countless hours of effort go into their maintenance as well as the creation and maintenance of dozens of other specialized agricultural thesauri. If adopted, a comprehensive agricultural thesaurus could offer opportunities to streamline indexing activities and would clearly be a unifying force in the bibliographic organization of databases. Discussion of a detailed global agricultural vocabulary began again in earnest in December 1988. In May 1989, representatives of CABI, the Consultative Group on International Agricultural Research (CGIAR), and NAL examined the problems associated with the development of a single, integrated thesaurus. AGRIS thesaurus experts and management were invited to join a more formal meeting to consider such issues as content, structure, and governance. The group plans additional discussion on the topic with a wide segment of interested parties (André, 1989).

Another cooperative undertaking in the realm of bibliographic control of agricultural publications has been the World List of Agricultural Serials Project, a joint project of the National Agricultural Library and CAB International. In a memorandum of understanding of March 1988, NAL and CABI agreed to work together to produce a comprehensive listing of agricultural literature published serially. FAO's AGRIS Processing Unit has supplied a list of titles indexed in AGRIS, and the Commission of the European Communities (CEC) has provided partial financial support. NAL has created a machine-readable file of over

50,000 records; CABI will publish the finished product. The primary objective of the *World List of Agricultural Serials* is to produce a comprehensive, regularly updated list of agricultural serials, giving essential bibliographic information. The first product of the database will be an international union list of approximately 11,600 agricultural serial titles indexed in AGRICOLA, AGRIS, and CAB ABSTRACTS. Access to this information will enable database producers to review their indexing policies to determine if any overlapping titles should be dropped, and the full database will serve as a source of additional titles to be considered for indexing. Both the union list and the comprehensive list will function as useful reference tools for librarians and others seeking information on agriculture published in serial form (Thomas, 1987).

All of the earlier discussed projects would have been virtually unthinkable before the application of computer technology to the problem of bibliographic control. Modern information technologies have created opportunities for access to, and exchange of, information that were not possible when bibliographic records were created manually. There are several new technologies that offer the promise of breaking new ground in the effort to organize and manage collections. Scanning, optical character recognition, and expert systems are all being used to capture information and to process it in a more effective way. Retrieval software and CD-ROM products are also shaping the future of bibliographic control. Several evaluation studies are underway to test the application of these new technologies. At the National Agricultural Library, the Indexing Branch has been experimenting with the use of scanners in the transcription of data used in the bibliographic description of journal articles. Using a hand-held scanner attached to a personal computer, a library technician scanned the abstracts to journal articles into a file. The abstract was subsequently merged successfully with the remainder of the bibliographic record which resided in a separate file on a minicomputer. Results demonstrated that scanning is faster than keying despite the need to correct numerous errors in the scanned text. A second phase of the experiment will test the scanning of abstracts with a more powerful flatbed scanner (Edwards, personal communication, 1989). Eventually NAL would like to see the development of a scanner and software combination that could automatically identify authors, titles, imprint, and other such bibliographic elements for coding in the bibliographic record.

Several other organizations are pursuing the development of automated tools that assist in the analysis of material to be indexed. Torben Friis, of Datacentralen in Denmark under the sponsorship of the CEC, has created a program that reviews the contents of abstracts, and based on the vocabulary used, prepares recommended indexing terminology using the *CAB Thesaurus* as a source (Friis, personal communication, October 1989). Vleduts-Stokolov (1987) described an indexing expert system developed at BIOSIS which is intended to generate BIOSIS concept codes and biosystematic codes through the processing of natural-language titles. The system will offer online assistance to indexers. Automated indexing would allow more material to be indexed, reducing or eliminating the labor-intensive and costly human indexing process, or, more likely in the foreseeable future, allowing rudimentary access to materials that might otherwise be entirely without access. With the advent of text digitizing and the conversion of full-text materials into ASCII, some have predicted that the need for cataloging and indexing as it is known today would be obviated with word-by-word access replacing the requirement for a bibliographic citation and controlled methods of subject access. Initial explorations of this approach indicate that human intellectual intervention to organize the information remains essential if the searcher is not to be overwhelmed by voluminous hits and led astray by false drops. As a consequence, agricultural vocabularies, authority control, and other elements of more traditional bibliographic control remain valid, even in the context of revolutionary information technologies. Yet there is no doubt that bibliographic control will continue to undergo transformations as librarians and information scientists work together to exploit technology to provide enhanced access to agricultural publications.

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The Future of World Agricultural Information Networks

MARTHA B. STONE

ABSTRACT

THERE IS A STRONG AND DYNAMIC FUTURE for agricultural information networks. This article reviews present day information networks, and how they have evolved as a result of new information technologies. The needs of the end user and how they influence the design of information networks; as well as how the increased demand for technology transfer and the evolving role of information systems, in this transfer process, have influenced the structure of national, regional, and international agricultural information networks are discussed. There is a recognition that information networks are not ends in themselves, but rather are critical tools to ensure the exchange, transfer, and utilization of information which will facilitate the increased quality and quantity of agricultural production.

The concept of networks in the field of library and information science is not new. *Networking* and *resource-sharing* are terms which appear in the classical library and information science literature and are subjects studied by students of the history of these disciplines. To focus on the question of the future of networks as they relate to agricultural information, it is necessary to review present day information networks in the proper context—i.e., how information networks have evolved as a result of new information technologies; how the needs of the end user have affected the design of information networks; and how the increased demand for technology transfer and the evolving role of information systems in this transfer process have influenced the structure of national, regional, and international information networks.

In setting this context, it is important to examine briefly the prere-

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quisite for a successful research network. For networks to be viable, it is evident that basic principles must apply regardless of the discipline or sector. Plucknett and Smith (1984) list the prerequisites:

1. The problem must be clearly defined and a realistic agenda for action must be drawn up.
2. The problem must be widely (commonly) shared.
3. Strong self-interest drives productive networks.
4. Network participants must be willing to commit resources—e.g., personnel, funding, facilities.
5. The availability of trained personnel to represent member institutions and make useful contributions to the network. Participants should be technically competent to undertake specific tasks and participate actively in network coordination meetings.
6. The existence of a strong leadership consisting of a steering committee and a coordinator. All participants should be involved in the decision-making process affecting the activities of the network and be treated as equal partners.

With these parameters established, a viable research network can be defined as a "voluntary association of research organizations with sufficient common objectives to be willing to adjust current research programs and invest resources in network activities in the belief that they will meet their objectives more efficiently than conducting all the research alone" (Banta, 1982).

If one substitutes "information" for "research," a similar definition and set of parameters can be applied. Thus an information network is "a systematic organization of separate units, interconnected for the purpose of achieving some goal that is more than any one of the units can achieve individually" (Duchesne, 1982, p. 1). More specifically, an information network refers to: "a formal association among libraries, documentation centres, archives, and global or regional information systems created with the aim of coordinating their efforts and sharing resources to satisfy information needs of users in a subject area and/or geographic region of mutual concern to network members" (Hailu, 1989).

Under the rubric of information networks, there are at least four categories relevant to the discussion in this article:

—*Resource Network.* A systematic organization of separate units, interconnected for the purpose of making information materials available. This concept is not restricted to libraries and library materials but includes information in a variety of formats. This type of access will grow rapidly over the next few years. Developments which will contribute to this growth include the spread of electronic publishing and of videotex service, and progress toward the realization and use of nationwide open computer/communications networks for information interchange.

—*Communications Network*. The complex of telecommunications and transportation services and systems for the transfer from one location to another of information, images and/or electronic versions of documents, and documents. Information transferred includes bibliographic and nonbibliographic information. For some purposes, it is helpful to consider the communications network as comprising telecommunications and transportation components.
—*Bibliographic Network*. A systematic organization of separate units interconnected for the purpose of engaging in the shared creation, maintenance, or use of bibliographic files and/or bibliographic databases, or in the provision of access to these files and/or databases. The files and/or databases may serve one or more of several different functions and provide service parameters. This definition includes both manual and computer-based activities and resources.
—*Library Network*. Two or more libraries engaged in resource sharing. Library networks consist of two major components: a bibliographic and communications network and a resource network. The bibliographic and communications network encompasses bibliographic file-based resource sharing, and the shared use of library processing services, and the hardware, software, and organizational arrangements required to provide these services. The resource network component is concerned with resource sharing relating to library materials and collections. (Duchesne, 1982, pp. 2-3, 5)

Stevens (1980, p. 405) provides a restricted definition of the term *library networks* referring only to those state, multistate, and national library organizations that are:

—supported primarily by payment for services from participating libraries;
—directed by a full-time staff;
—controlled by an independent government body with a high level of involvement (generally through a board of directors from participating libraries);
—built around a cooperatively maintained bibliographic database in machine-readable form;
—linked online by a telecommunications system.

In the current environment of information processing, dissemination, and utilization, the term *library network* will be increasingly superseded by terms more oriented to functions, services, and transactions—e.g., *information network, document delivery network,* and *bibliographic processing network* (Duchesne, 1982, p. 5).

The Role of AGRIS

Within these parameters of information networks, the question of agricultural information networks may be addressed. There is little doubt that this discussion must begin with an overview of AGRIS

(International Information System for Agricultural Sciences and Technology), based in Rome at the Food and Agriculture Organization (FAO) of the United Nations. It is not possible to discuss the future of agricultural information networks without understanding the role of AGRIS in the acquisition, processing, and dissemination of information to various target audiences in the agricultural sectors, and its role in the information transfer process particularly to the benefit of developing countries. It is true that there are many difficulties facing AGRIS today, but if one wishes to be in a position to discuss clearly the future of agricultural information networks, it is essential to underscore its present day status with all its strengths and weaknesses.

History reveals that the prime objective of the founding fathers of AGRIS was to merge the large agricultural databases of CAB International (CABI), formerly the Commonwealth Agricultural Bureaux (CAB), and the National Agricultural Library (NAL) with several other databases to form an improved world agricultural information system. A group of experts was also appointed in the early 1970s to evaluate existing agricultural information services and propose possible frameworks for an improved worldwide agricultural information system. What emerged instead was a third major force in agricultural information services, AGRIS (Mann, 1986).

It is widely recognized that the agricultural sector will continue to remain a highly subsidized one. This is particularly true in developing countries. It follows that agricultural research and development, and the information services required to support them, should be regarded as service type rather than commercial type activities. Indeed, the information services of AGRIS and the NAL appear to have been conceived with this philosophy in mind, with the ultimate goal of creating a single, coordinated, global system for agricultural and food information. AGRIS, with its unique worldwide network of more than 130 national and regional input centers, is providing the necessary framework and impetus. CAB International was founded with similar objectives, and its recent success in obtaining full international status would appear to be a clear indication of the move to greater international cooperation (Mann, 1986). CABI is no longer limited to supporting the information needs of commonwealth countries. In the identification of services and products, the needs of all countries, developing and industrialized, can be considered.

In the AGRIS model, a formula has been found for information sharing which responds to global needs and places no country in a position of dependency. The strength of AGRIS is that, as a cooperative international information system or network, it is a mechanism which provides for effective north-south collaboration on the basis of equity and which helps the suppliers of information services, whether public or private, to augment the resources which they can offer to their target audiences. Currently the main deficiency of AGRIS is that it lacks an effective document delivery component to support the bibliographic citations contained in its database. The frustration, on many levels, which this causes to the potential user has been discussed at length in other forms (Woolston, 1984).

It must be acknowledged, however, that an attempt has been made to address this weakness in the AGRIS network. The David Lubin Memorial Library at FAO has played a major role in the AGLINET (Agricultural Libraries Network). This network was established in 1974 based on statutes formulated at a joint FAO/IAALD (International Association of Agricultural Librarians and Documentalists) symposium in 1971. The goal of this international cooperative network was efficient document delivery through flexible and effective cooperation among the large agricultural libraries of the world and regional decentralization of responsibilities. By 1986 membership had increased to twenty-three and the new idea of adding broad specialized libraries as members had been accepted. There is clearly no single solution to satisfying user demand for agricultural documentation. If there is to be equity among all participants in the global information system, then developing country libraries need to be established and strengthened. In addition, responsibilities in the industrialized world should be clarified as well as decentralized, and AGLINET libraries should be responsible for delivery of national imprint material (David Lubin Memorial Library, 1986).

INFORMATION TECHNOLOGIES

The question can be posed, To what degree will the rapid developments in the field of information technologies have a positive impact on the viability of information networks and more specifically agricultural information networks? In this article, little attention is placed on new information technologies and their significant role in aiding the explosion of information processing, transfer, and utilization. However, in considering the future of networks, it is essential to shed some light on the boundaries which have been expanded due to the introduction, development, and enhancement of information technologies.

Martin (1987) indicates that the most significant impact on the nature of the automated network in future years will be the fact that the traditional library is unlikely to change very quickly from its current physical form or mode of serving users to any other form. She states:

> If past experience is a guide, each change in library networking between 1986 and 1990 should not be significant in and of itself, but the totality of the changes will make the networking structure of 1990 rather different from that of 1980. Also, in this case, past experience may not be sufficient to provide us with clues regarding the future. Too many significant issues lie unresolved, and too many technologies which have the potential to affect networking are under development, to allow a simple extrapolation from the network structure of 1986. (p. 31)

With the exponential growth of information, especially in the scientific and technical domain, the need for effective and efficient methods for the transfer of information is becoming even more pressing. Data communication techniques, which are nonreal time and relatively low cost in nature, with hard copy outputs if desired, can facilitate information exchange and transfer. Computer-based messaging, bulletin board, and conferencing systems are increasingly being used as the computer and telecommunication technologies converge.

There are at least three technological trends which are significantly increasing the potential role of information networks and their infrastructural components:

> 1) Decreasing costs, increasing reliability, and relative ease of use of much recent communications technology.
> 2) Considerable technical development in the transmission of information, both globally through a rapidly growing network of communication satellites...and more locally through cable networks and small-scale transmitters which open up opportunities for community-based radio and television services.
> 3) Integration of the various components of communications technology, especially the bringing together of the data processing and storage capacity of computers with the ability of telecommunication systems to transmit electronically-coded data extremely quickly. (Garforth, 1986, p. 186)

Although this article, as previously mentioned, does not dwell on the growing impact of information technologies on agricultural networks, it is important to attempt to make the distinction between the use of these technologies for facilitating the transfer and exchange of "information about information"—i.e., bibliographic citation exchange—and the transfer and exchange of "information." Some of the documented uses of information technologies demonstrate this distinction.

At the present time, the most common use of CD-ROM technology in the field of information handling and exchange is to provide access to bibliographic references. Often abstracts are available but rarely is full text provided. It must be underscored that these comments are limited to the application of CD-ROM technology to information networks and, most specifically, to agricultural information networks.

Two years ago, The International Development Research Centre (IDRC) participated in an evaluative study with CAB International to determine the viability of CD-ROM as an information technology to facilitate equitable information access and utilization (Beaumont, 1988). From a wide range of users—i.e., librarians, information specialists and subject specialists—it became evident that the accessibility of CD-ROM in stand-alone microcomputer workstations, with potentially powerful online retrieval capabilities, encouraged use of information systems by researchers, policy makers, and other end users who had not traditionally had access to online searching. It was determined that the technology would fit easily into existing organizations and would be one way to allow libraries and information centers to become more proactive rather than reactive in providing new and enhanced services.

In the study it was found that in using the technology for retrieving references, most users searched for references to items or subjects already known to them. The availability of abstracts did allow searchers to assess the value of individual articles more effectively. However, the participants in the study stressed the need for access to a wider variety of full-text databases. Once more the issue of "document access" or "document delivery" presents itself. For many of the participants there is a sense of isolation from the mainstream of information and library technologies. CD-ROM, in conjunction with microcomputer technology, has the potential to support the distribution of many bibliographic and reference tools that until now have been unavailable or beyond the budget of many organizations, particularly in developing countries.

Reference-based information technologies are also being investigated by the NAL. The use of laser videodisc technology is being evaluated as a means for disseminating agricultural information (André, 1985). The study is being funded as part of a strategic planning effort by the U.S. Department of Agriculture to assess long-range opportunities in the utilization of technology as it relates to agriculture and agricultural information. There is a growing awareness within the agricultural community of the great potential of computer technology for information access and delivery. This videodisc/microcomputer evaluation will provide significant information on the potential uses of these technologies. The focus of the evaluation is the potential of laser videodisc technology used in conjunction with microcomputers for storage and dissemination of agriculturally related full-text databases. The system will include all hardware and software necessary to store and retrieve a full-text file together with a videodisc as the storage medium for the database selected.

Laser technology has the potential to change significantly the means by which publications and databases are stored, distributed, and used. The results of this evaluation will provide data on user acceptance of microcomputer/laser videodisc systems as a means of access to textual agricultural information (André, 1985). This is an extremely important study, for it can point the way toward addressing the problem of document access which is a major obstacle in achieving a fully viable information network.

As stated in the beginning of this section, information technologies have facilitated the transfer, exchange, and utilization of information and have brought dramatic change in the structure and function of information networks. Nowhere is this more apparent than in the agricultural sector. Information technologies have also influenced the profile of the participant in the information network. The end user is viewed as the active network participant, especially in those networks which are based on information exchange and not reference or bibliographic citation exchange.

An important end user and a critical participant in information networks is the agricultural extension worker. When the distinction between reference-based and information-based information networks is considered, it is very important to understand how this target group uses information. Sattar (1984) reported on an interesting study which examined the information-seeking behavior of agricultural extension specialists. In his paper, he stated that extension specialists were in constant need of information, and that most of them turn to personal sources to seek this information. The study found that information sources accessible through libraries were not perceived as useful by extension specialists. Sources such as indexes, abstracts, and databases were rated very low and of little relevance when ranked by the specialists. This of course means that they tend not to use these sources to answer questions or to solve problems.

There are two interesting examples of microcomputer-based and videotext information systems which have strengthened the "networking of people" at the grassroots level. It is perhaps significant that the examples come from the United States, for it is in the industrialized countries where the use of information technologies for problem-solving rather than for the documentation of problems already solved and recorded in the literature is most apparent. If there is a negative aspect to this reality, it can perhaps be argued that these technological developments may indeed be a factor in exacerbating the gap between the "have" and "have not" regions of the world.

In the United States, which has a history of capital-intensive farming, the microcomputer is being used for generic functions such as calculating budgets and a host of user-specific functions such as calculating optimal land use for a specific farm. Another function for the on-farm computer is to provide communication capabilities with national agricultural databases and to establish electronic mail systems among farmer interest groups. Using a microcomputer and a modem, farmers can link up with a wide range of computer networks. These networks provide information on weather conditions and forecasts, commodity prices, and current market prices for livestock (U.S. BOSTID, 1986).

The Agricultural Computing Network (AGNET) celebrated its tenth anniversary in January 1985. It was a nonprofit international network designed to be a user-friendly management tool for the agricultural community with participants in forty-seven American states and ten other countries. The user profile was varied with many sectors represented—e.g., education, agribusiness, producers, government, credit institutions, farm managers and consultants, computer dealers, and software distributors.

AGNET developed into a system that offered three basic types of services: management models, current information, and electronic communications. Participants could use any combination of services depending on the nature of their business, and all had access to every program in the general AGNET library. The various models in AGNET helped participants make decisions in the general areas of crop and livestock production and marketing, financial management, and home economics. During its first decade of existence, AGNET evolved from a handful of management models for use by university personnel to an international network where private and public concerns worked together to serve the diverse agricultural community (Murray, 1985). Although AGNET ceased operations in December 1988, it successfully demonstrated the utility of such networks.

The final example of an information-based network, directed to the grassroots end user and utilizing videotext technology, is the Green Thumb system. The U.S.-based Green Thumb system was designed especially for farmers and was jointly funded by the U.S. Department of Agriculture and several university communities. Through the Green Thumb system, farm families can access information dealing with farm markets, weather news, agricultural innovations, home economics, occupational information for youth, and news of local farmers' meetings. The Green Thumb videotext system is seen as a natural combination of the microprocessor and existing telecommunications equipment—i.e., the TV set and the telephone.

The new microprocessor-based information technologies are beginning to influence the nature of U.S. agriculture. Case (1987) argues that there is evidence of the transformation of farming to more of an information occupation. This development also highlights the critical gap between the north and the south. It is becoming evident that the technologies of the 1980s are working to the disadvantage of some rural people. For example, cable television is generally unavailable outside the city limits, and the rate of adoption of microcomputers by farmers is clearly lower than that of nonfarmers.

During this decade, a variety of information-based agricultural information networks somewhat similar to the Green Thumb system have become available, though not all have been successful. For example, the Grassroots videotext system, based in Manitoba, Canada, had a great beginning and was full of potential, but, most likely due to a poorly defined target audience, its services could not be sustained.

Information technologies, in their various structures and formats, have placed information specialists in a position to consider many facets of the information handling process, and to bring the needs of the end user more effectively into the design and implementation of the information network. Clearly information technologies are a critical factor in setting the agenda for the future of agricultural information networks.

Obstacles

There are some obstacles which threaten the viability of agricultural information networks of the future. These obstacles can be defined as the nonexistence of the prerequisites for a successful research network which were cited at the beginning of this article (Plucknett & Smith, 1985). Within the context of agricultural information networks, this could mean that:

—the subject scope has not been clearly defined and/or the parameters have not been firmly established;
—among the potential participants, there is no commonly shared view of the subject scope, the boundaries of the network, or of the services or outputs to be provided;
—the network participants do not believe strongly that they will personally benefit by being active participants and that these benefits will outweigh their costs;
—there does not exist a sufficient number of adequately trained personnel, representing member institutions, to make useful contributions to the network. Specifically, participants are not technically competent to undertake specific tasks and to participate actively in network coordination meetings;
—network participants are not prepared to adhere to established governances, nor to commit resources—human, financial, or physical; and
—networks lack a strong coordinating structure in the form of a coordinating committee and a coordinator. As well, network participants are not considered equal partners, and they are not involved in the decision-making process.

Henriette Avram and Mary Ellen Jacob are recognized for their work in the area of information networks and resource sharing. Both have written about the future of information networks and some of the key issues which must be addressed to ensure their continued viability. Avram (1986) has stressed four areas of important network issues:

—local systems: where the temptation of autonomy may subvert the desire to link with others;
—linking: with the development of the LSP (Linked Systems Project) having gone beyond just a promise, but not far beyond;
—linking standards development: a sine qua non for network development; and
—database ownership: a problem that has taken on increased importance, now that linking is more possible.

Touching on some of these same issues, but from a slightly different perspective, Jacob (1985) provides insightful commentary about five broad areas which can have an impact on future information networking: (1) She predicts poor economic conditions, including shrinking resources leading to reallocation, a need to question who pays for what, and continued concern for telecommunication costs especially in some regions of the world; (2) from the perspective of technology, she stresses standards, increased control, including international barriers, and the need for more service-based research and development, such as intelligent gateways; (3) her comments about social factors include changes in demographics and a shift in values toward the perception of information as a commodity; (4) she envisages much more retraining which she refers to as "lifelong learning"; a need for computer literacy; and increased obsolescence of the physical plant, equipment, and staff; and (5) finally, in the area of government and legislation, she addresses the problems of access to government-funded information; a possible tax on information as the information services sector grows and the "hard" industries decrease; and control and ownership of information.

CHANGING PROFILES OF THE AGRICULTURAL SECTOR

The environment within which agricultural information networks exist and contribute to the transfer of information has changed markedly over the years. The information needs of the agricultural research community have changed, and the demands made by users of this information have become more complex and focused. As discussed previously, the ultimate end users of the results of the research—the agricultural extension specialist as well as the farmer—have become key players in the information transfer process. Their presence has already had a major impact on the design, organizational structure, and services of the networks. These changes are not country or region specific, and, in fact, one can see the impact that some of the information technologies have had on modifying some of the local or national information networks that are international in scope and access.

This article examines some of the information-based agricultural information networks located in the United States. It is not intended to give the impression that the major developments in information networks in the United States are solely due to the switch in emphasis from reference-based information networks to information- or problem-based information networks. Of course, the entire structure of U.S. library networks has been undergoing change. There are layers upon layers of networks, including national, regional, state, and local networks. This is often referred to as the "network within a network" phenomenon (Kenney, 1988). This will allow a start to be made in addressing the issues and concerns raised by Avram and Jacobs.

To date, in the United States, computer-based library networks have developed in a vacuum with little connection or coordination with other national computer networking efforts. The networks developed by the major bibliographic utilities in the 1970s are a good example. There must be a convergence between library networks and general computer networks, and libraries must enter the mainstream of national computer networking. This will result in an entirely new condition as the utilities take on new responsibilities as database servers, and library systems and widespread computer networks allow equal access to the full range of available databases (Kenney, 1988). This will allow a start to be made in addressing the issues and concerns raised by Avram and Jacobs.

Change is evident in other regions of the world. The literature documents the significant growth in agricultural information networks in Europe and North America. What is perhaps of interest is the development of regional and national agricultural information networks in many of the developing regions of the world. One can see as well the information needs of the end user being taken into account as the networks are being designed. Some networks are clearly directed toward the needs of information intermediaries while others are focused on the needs of the farmer through the intervention of the agricultural extension worker.

Worthy of mention is the system proposed by the Arab League Documentation Centre (ALDOC). Agriculture is a major sector of the economy and social structure of most developing countries, including many Arab nations. In spite of very large investments in this sector, agricultural development in the region is not satisfactory. In addition, the production of agricultural information within the region is very meager. To address the problems of information collection, processing, dissemination, and access, ALDOC will develop and manage a regional agricultural information network.

If this goal is reached, this regional network will assist in providing bibliographic control and exchange of information with possible advantages in economy of scale, deployment of financial and human resources, and speed. With strong leadership and coordination, national centers will be able to concentrate their efforts on identifying relevant information and transmitting data to regional agencies for processing. With a strong regional center, financial viability will not be an obstacle which must be overcome (Chaudhry, 1987).

In China, it is not surprising that the situation is somewhat different. The focus of this massive country is on agricultural education and extension. It is crucial to get the information into the hands of those who deal directly with the farmer. Agriculture is a key, if not the central, component of the Chinese economy, as more than 80 percent of the 1.2 billion population live in rural areas, and more than 350 million are in the rural work force.

The Chinese government places a high priority on agricultural development, partly because of the problems of feeding the huge population, but also because of the declining area of land suitable for cultivation. The expansion of urban areas, combined with problems of land degradation and environmental pollution, continues to exacerbate the situation. As well, the government places a very high priority on improving the quality and quantity of agricultural education as a means of increasing the flow of information required to maintain sound and sustainable agricultural systems.

In the past, agricultural extension has not been closely allied to agricultural education. Such a service is provided by agricultural extension centers in each province and sometimes by village level centers. Today there is a recognition of the need to link the extension centers and the sources of agricultural information which exist in the agricultural universities and research institutes. Attention will now be paid to how information is sought, used, and transferred into action, and, perhaps more precisely, how the characteristics of new ideas and technologies influence the acceptance rate by the farmer (Judge, 1986). Within this developing country context, the integration of the end user into the design and structure of the agricultural information network seems essential and inevitable.

In concluding the discussion on the changing environment within which agricultural information networks function, it is important to underscore the inequity in the access to information by industrialized and developing countries. There seems to be a clear indication that the changes which have occurred in the structure and outputs of the networks only heighten this inequity. The viability of the networks of the future will depend upon reducing, if not eliminating, this inequity or imbalance. To a large measure, due to the introduction of new technologies in the information processes, networks are indeed becoming global and thus participants are coming from all regions of the world. It is therefore essential that all participants have "ownership" of the network and feel committed to its success.

THE FUTURE OF THE AGRICULTURAL INFORMATION NETWORKS

It is recognized that the problem of information control in electronic form by industrialized countries is not unique to the field of agriculture. However, there are several aspects of agricultural information that set it somewhat apart from other disciplines and thus account for some of the difficulties of creating adequate information networks for its dissemination. First, agricultural information is scattered across many disciplines. The interdisciplinary nature of agriculture means that relevant information exists in many different databases and that an agricultural information specialist must be knowledgeable about, and able to access, a wide variety of sources. Second, a great deal of the output of agricultural research and extension activities exists in a grey or unpublished literature form, thus it is not widely available. Third, as mentioned earlier, agricultural information must exist on many levels to serve many target audiences, from researchers through policy makers and extension workers to farmers. Finally, agricultural information is being generated throughout the world—research is being undertaken, data collected, and techniques developed, modified, and transferred in all geographical regions and in many languages. Even the very small and very poor countries have the potential to contribute to the international body of agricultural information (Griffiths, 1985, pp. 1-3).

A report prepared by the U.S. Congressional Research Service, U.S. Library of Congress (1983), identified several key issues in an attempt to highlight the various dimensions of mounting and sustaining an imaginative support effort which could adequately furnish far-flung rural people with timely, comprehensive, accurate, and relevant information of considerable variety. The issues considered in the report are pertinent to the debate on the future of agricultural information networks, for they clearly point to where the networks must place their emphasis if they are to continue to be critical to the information transfer and utilization process. The congressional report identified the following issues:

—The kaleidoscopic roles and responsibilities of established and emerging entities, both in the public and private sectors, who serve as information providers for the agricultural community.
—A consistent requirement to determine to what extent and under which conditions government collected data could be accessed by private vendors.
—The conditions under which individuals or groups at the local level could influence, even to a modest degree, the information offerings (content, frequency, form) made available to them.
—The extent to which formalized responsibility could be assigned to information providers and systems implementers regarding such post-installation activities as training, maintenance, and the modification of files and software.
—The ramifications of private organizations acquiring government-developed data files and/or software which would then be modified, resulting in "value-added" products and services, with particular attention to ownership of such improved elements.
—The diversity of hardware and software offerings which has raised vociferous arguments for and against standardization imposed by either the government or the information industry.
—The need to examine efforts which could be undertaken at present to protect the confidentiality of personal and corporate data being entered into some of the agriculturally oriented online files. (U.S. Library of Congress, 1983)

Regardless of the subject scope or parameters of the information network, or the agreed upon common problem(s) which it may seek to address, Wasserman (1984) sets the context for agricultural information networks in the future. He states:

> the idea of a network is one which transcends technological process. What it suggests is that there is utility and validity in combining strength through ties and links, thereby enhancing effectiveness of each group member beyond his individual capabilities. Moreover, once the concept of interdependency is accepted, far more is feasible than before. Duplication of effort is reduced, but

> what then comes to be implied is the need for extended understanding. This leads swiftly beyond the level of documentation and bibliography. For it implies the conduct of inventories first of publications, then of ongoing research. It implies factual details and knowledge of organizational strengths and research capabilities. And ultimately, it leads to the recognition of precisely what it is that is necessary in recourse [sic] to information sources external to the culture itself. When this happens, the group transcends the limits of the local scene and more surely finds its footing in the context of the international structure. (pp. 8-9)

There is a strong and dynamic future for agricultural information networks. This is true, whether the emphasis is on bibliographic citation/reference-based information networks or on information-based/problem-oriented information networks. It is also true regardless of the target audiences, be they researchers, policy/decision-makers, extension workers, or farmers. Finally, this is true, regardless of the geographical location (i.e., industrialized or developing countries) or regardless of the level (i.e., national, regional, or global).

This is not to say that there are not many obstacles to overcome. There are many issues to be addressed before the agricultural information networks of the future may be considered viable. Nevertheless, a key ingredient for a strong future is implied—the existence and commitment of those who must be responsible for the design, implementation, management, and ultimate use of the networks. There is also a recognition that the agricultural information networks are not ends in themselves but rather are critical tools to ensure the exchange, transfer, and utilization of information which will facilitate the increased quality and quantity of agricultural production.

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Agricultural Information in Developing Countries

SUSAN C. HARRIS

ABSTRACT

THE NATURE OF AGRICULTURAL RESEARCH affects the agricultural information sector in the developing world. This article will first discuss some issues or assumptions that information specialists in industrialized countries may find useful to examine before looking at the problems of the developing world and solutions that have worked there. These include the diversity of conditions, the rate of change in information work in the developing world, and the question of technology transfer and whether it is a universal good. It also covers problems associated with isolation—political, organizational, and cultural. The article looks at the economic situation of agricultural research and information as 1990 approaches, focusing on changes in patterns of interest and funding for agricultural information work in Latin America and the Caribbean, which, while the cycles will differ, are representative of, and similar to, those of other regions. Finally, the article discusses solutions for a variety of libraries and information centers, especially networking and technology-based solutions. Many of the sources identified in the references are nonconventional and not retrievable through bibliographic databases.

INTRODUCTION

Lancaster and Beecher (1981) have discussed four characteristics that make agricultural information unique and different from other scientific literature (also listed by Sattar & Lancaster, 1984). These are: the interdisciplinary nature of agricultural research, the fugitive nature of the literature produced in agricultural scholarship, the universal

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applicability of agriculture and its literature, and the diversity of the treatment and presentation of this literature. Each has a unique impact on agricultural information work in developing countries (Menou, 1981; Sattar & Lancaster, 1984).

Moreover, beyond the characteristics spelled out by Lancaster and Beecher, other characteristics are more or less universal in the developing world. These include isolation of several sorts—geographical, professional, organizational, and cultural—and a general shortfall in resources—money, equipment, and trained personnel—that exceeds the universal shortfall afflicting libraries.

The interaction of these two sets of characteristics serves to define the parameters of the situation in the developing world agricultural information sector. Agricultural information specialists in the developing world deal with a commodity that is complex and difficult to manage because of its broad disciplinary and geographical base as well as its diverse formats. They must deal with this commodity without adequate bibliographic control, in relative isolation and without financial and personnel resources—a very difficult assignment.

This article will discuss issues or assumptions that information specialists in industrialized countries may find useful to examine before looking at the problems of the developing world and solutions that have worked there. These include the diversity of conditions in the developing world, the rate of change in the conditions surrounding information work there, and the question of technology transfer and whether it is a universal good.

In the process of examining the problems of the developing world, this article will not focus on the lack of resources although that lack is often acute. Instead, it will cover problems associated with isolation. One obvious form of isolation is geographical, which affects almost all information activities. Additionally, political isolation at the national level, organizational isolation, and cultural isolation cause problems for agricultural information workers. In asking librarians and documentalists from various environments and situations what problems they face, the word that appears in almost every reply is *isolation*.

The state of agricultural information work at any time is related to the world economic situation especially in agriculture and agricultural research. So this article will examine the situation in various parts of the world. It will then focus on changes in patterns of interest and funding for agricultural information work in Latin America and the Caribbean, which, while the cycles will differ, are representative of and similar to those of other regions.

Finally, the article will discuss solutions that have worked for a variety of libraries and information centers. Two broad approaches stand out—networking and technology-based solutions. These are familiar to all librarians and information specialists in the 1980s, but the ramifications of implementation in the developing tropics are different than in heavily industrialized countries of the north.

In examining assumptions, problems, the current state of affairs, and solutions, this article will attempt to provide a starting place for those wanting specific information about one country or region of the world. Probably the most common characteristic of library and information work anywhere is the willingness to help colleagues and information users in gathering data. Nonetheless, sources of data from far-flung parts of the world are not always easy to identify, and many of the sources identified in the reference section of this article are not retrievable through bibliographic databases.

Assumptions and Issues

Before discussing some of the special problems and innovations encountered in the provision of information services in that broad cross-section of the world called developing countries, it is worth examining underlying assumptions and introducing a few caveats. These will not be new to anyone with an ongoing interest in international agricultural information. However, an increasing number of the U.S. and European information professionals are finding opportunities to work in developing countries, and information sources for them are sharply limited. For example, one information specialist attending the INFO '88 Conference in Havana, Cuba, wrote afterward:

> the amount of activity and the depth of knowledge in the library and information field, particularly in new technology and promotion of services, in the Latin American region was quite amazing to a non-Latin-America watcher....I learned an enormous number of things technical, professional, social, and personal from discussions with Brazilians, Cubans, East Germans, Mexicans, Russians, Spaniards, Venezuelans—which has added to my store of knowledge and enriched my experience. (Raitt, 1989, p. 2)

Diversity of Conditions

First, it is essential to keep in mind the great diversity in the individual situations found in libraries and information centers within and among the countries of the developing world. The agricultural libraries of the United States run the gamut from the great libraries like the U.S. National Agricultural Library (NAL), Beltsville, Maryland; the Mann Library at Cornell University, Ithaca, New York; the agricultural libraries at the University of Illinois, Urbana-Champaign; or the University of California at Davis, California; to the rural public libraries with a national average budget of $30,000/year (Vavrek, 1989). Just so, the libraries of the developing world come in all sizes and varieties.

Information infrastructure is used in the developing world to indicate that complex set of institutions and ideologies that includes: libraries, librarians, library instruction, books, periodicals, bookstores, book vendors, databases, computers, telephone lines, publishing houses, authors, and other elements essential to the generation and dissemination of scholarly information. Some of the most sophisticated information sectors of the developing world are those of Malaysia, the Philippines, Brazil, Cuba, and Mexico. (This group of countries is sometimes called the Newly Industrialized Countries or NICs.) In these countries there are libraries and information centers that are very much like those found in the United States or Europe, except that they have much larger staffs and much smaller collections. They may be more automated in some respects and less automated in others, but that is the nature of technology across the world. However, in these countries, as in the United States, the large libraries tend to be located in urban areas.

Outside the NICs, other countries that have developed substantial information infrastructures in agriculture include: Colombia, Costa Rica, Panama, India, and China. Quite a few countries have some elements of an information infrastructure (e.g., a few good libraries, a professional association, or university education for information professionals) but lack other elements (such as adequate buildings or staff, money to build collections, or facilities for interlibrary loan). There are also successful information centers in countries that are generally characterized by lack of resources.

More sophisticated infrastructures will include national bibliographic databases, projects for resource sharing, and computerization of information processing at various levels. One of the best measures of an information infrastructure is the degree to which user services and bibliographic instruction have progressed. Library education has tended to focus on technical services rather than user services and/or the management of information services (N. Barrantes, personal communication, May 24, 1989; Bell, 1983; Instituto Interamericano de Cooperación para la Agricultura (IICA), 1986; Lopera Quinceno, 1988; Malugani, 1984; Nanda & Goyal, 1985-1987; Syed, 1981; Syed, personal communication, June 16, 1989). Recently, information technologies have received considerable attention (see, for example, Arboleda-Sepulveda, 1986). The Library School at the University of Panama has a new curriculum designed to produce a professional information manager (N. Barrantes, personal communication, May 24, 1989). But the concept of attention to the user's needs and the effective attitudes for a positive information professional/information user interface are not universal (Diop, 1988).

Hailu (1988) cites a survey in Ethiopia where more than 90 percent of researchers, educators, and extension workers responded that the institution's library does not meet their information requirements. A survey of researchers in Colombia (Harris, unpublished data) indicated that more than 50 percent were dissatisfied with their institution's library or information center. This is mainly due to the weakness of collections, but it is also due to the librarian/user interface.

India has a different kind of problem that is not an uncommon one. India has many well-trained information professionals and many agricultural libraries that provide a range of services, but it is a very large country and the efficiency of the information sector is severely hampered by the lack of systematized cooperation. There is no national library system. The lack of development of systems of cooperation hampers specialists in that country and others, and keeps them from making the best use of the available resources (Eswara Reddy, 1987a; Ahsan & Lal, 1989).

The most generally impoverished countries are those of sub-Saharan Africa, excluding South Africa, but a number of countries in Latin America, the Caribbean, the Pacific, and Asia are also very undeveloped in agricultural information. Additionally, there are still huge areas throughout the developing world where no information infrastructure at all has been developed. The rural areas of even the most sophisticated countries are still lacking in almost all kinds of social welfare and communication infrastructure, and libraries are no exception.

In the oil-rich 1970s, many developing country governments often began building a substantial library infrastructure only to have to cut back substantially in the debt-poor 1980s. The 1970s were also characterized by substantial support of agricultural research and, thus, agricultural information. The 1980s also did not fare so well. Thus, generalizing may be useful in looking at the broad spectrum of agricultural information in the last years of the twentieth century, but it is not advisable to try to apply the generalizations to specific libraries or information centers.

Change Rate in the Information Infrastructure

The second issue to be discussed is that the situation must not be assumed to be static. The rate of change in the information sector in the developing world is impressive. Certainly university libraries have collected biological literature of use to the agricultural scientist for at least a century. And in many countries agricultural research institutes have been established for well over half a century. But the last forty years have brought accelerating change to the information sector of developing countries. (For example, see Malungani [1984] for figures on the number of libraries and information centers in various countries in Latin America and the Caribbean, by decade, from the 1950s to the 1980s, and Instituto Interamericano de Cooperación para la Agriculture [IICA] [1978] for the progress of agricultural information activities in the same region. See also, Ahsan & Lal [1989] for their description of the birth and growth of the major agricultural libraries in India. The Philippines newsletter, *Aginfolink,* has published a series of articles on the history and services of Southeast Asian agricultural libraries, and the same pattern can be seen there.) The explosion in the agricultural information sector is the child of the developing nationalism of the post-Colonial era and of the Green Revolution. (The *Green Revolution* is the term applied to the adoption of the so-called miracle varieties of crops, especially rice and wheat, in developing countries. These varieties allowed countries that could provide at least marginal levels of inputs, such as fertilizer and irrigation, to vastly expand agricultural productivity. For a brief bibliography on the Green Revolution, see Harris & Rizo, 1985.)

In India, for example, the Imperial Government of British India established departments of agriculture in every province in the 1880s, agricultural colleges in the early 1900s, and the Imperial Agricultural Research Institute in 1905. In 1929, the Imperial Council of Agricultural Research (ICAR—later the Indian Council of Agricultural Research) was established, and the ICAR Library followed in 1930. But it was not until independence, in 1947, and then the arrival of the high-yielding rice and wheat varieties of the Green Revolution in the 1960s that agricultural information really began to expand its influence (Banerjee & Moitra, 1984-1985).

In 1989, there is virtually no country that does not realize the importance of its own agricultural productivity or that is not aware that the need to import food makes a country vulnerable. Increasingly, governments of all convictions also understand that a well-developed information sector is essential to improve and sustain agricultural productivity. Thus there has been some increase in general support to libraries at agricultural universities and research stations. More dramatic, however, has been the rise in the number of specialized information centers and the development of computerized bibliographic and numeric databases on the national, regional, and international level. Like all growth and progress, this change has not been accomplished without its attendant problems.

International Assistance and Technology Transfer–
A Universal Good?

In the heavily industrialized parts of the world where information professionals are trying to cope with the stresses caused by the growing demands and shrinking resources of the Information Age, it is tempting to think that some kinds of problems are the unhappy domain of the less developed countries (LDCs), and that the developed countries have found solutions to these problems and have cheerfully obligated themselves to share them. This is a premise that, at the very best, merits careful consideration, and, at the worst, may lead to disastrous results.

Syed Salim Agha is the chief librarian at the Universiti Pertanian Malaysia, Serdang, Selangor, Malaysia, a sophisticated, modern agricultural library. Syed (personal communication, June 16, 1989) says that "LDCs...have been, by default and probably by design, segregated from the mainstream of information access and systems development. The problem is further accentuated by currency exchange, which leaves LDCs at a disadvantage, and by the problems of gaining access to the materials required." He also comments that "the pricing structure for publications is based on the marketing systems of the developed countries (DCs) and the relative cost of living. The costs of books and journals appear astronomical by the standards of other countries." The effect of this economic structure is that libraries in developing countries are unable to afford basic resources for the study of science. Eres and Bivens Noerr (1985) provide excellent data for the availability of journals, abstracting journals, and indexes for scientists of all sorts in the developing world. They indicate that the average number of journal subscriptions per scientist for the lower income countries is 524 subscriptions while the average for the higher income countries is 38,094.

The situation for books is not much better. A survey of bean researchers in East Africa (Harris, unpublished data) indicated that twenty-two of sixty-five scientists could not think of a single book publication that was useful to them. Respondents indicated that this was because they had scarcely any access to books. Twenty-five of sixty-six respondents said the method of book acquisition was to personally purchase them—a purchase which, several remarked, could only be made when they were abroad—an infrequent occurrence. Only thirty-four of sixty-six obtained books from a library. This unfortunate situation is discussed off and on by members of the International Association of Scholarly Publishers (IASP), Oslo, Norway, in their newsletter. Many in IASP believe that publishers in industrialized countries would lose very little, if anything, by selling rights to publish inexpensive copies and translations in the Third World. Doing so would bolster publishing efforts in the Third World and make information more accessible to libraries and users.

Crowther (1984a) discusses a fear that is pervasive among information professionals in the developing world. Crowther's thesis is that the modern systems of information in Latin America are an integral part of the "transnational style of development," and those systems are biased toward the ends of the transnational community. He points out that countries of Latin America are trapped by an inability to advance significantly toward organizing, storing, and disseminating the mass of information that arrives from outside. The inability to sort these data by previously defined national priorities affects all potential users of scientific, technological, and socioeconomic data who must simply accept the priorities imposed by the information system. Meanwhile, other, perhaps more valuable, data are not accommodated by the information systems of the transnational community. These data, which might reside mainly in the oral tradition of the farmer, for example, or in unpublished reports, or in the minds of colleagues, are ignored in the development process. While not all information workers are as strongly opposed as Crowther to the transnational bias, many are indeed worried that national identity could be unduly influenced by outside interests and that an appropriate path to development could be lost in the process.

Development agencies (more often called international than transnational) are not unaware of the problems of bias. There is substantial literature on exactly this problem as it applies to the technology of agriculture. (The Harris & Rizo [1985] bibliography provides references to works that deal with the problem as it applies to agriculture.)

The international information sector is also aware of the need to collect the indigenous wisdom of the farmer. Kerian Broadbent (1989) of IDRC (International Development Research Centre, Ottawa, Canada) discusses this need in his report for a meeting of the international agricultural research centers coordinated by the CGIAR (Consultative Group for International Agricultural Research, Secretariat in Washington, D.C.). John Metcalfe of CAB International (CABI, Wallingford, Oxon, England) and John Woolston, recently of IDRC and ICARDA (International Center for Agricultural Research in Dry Areas, Aleppo, Syria), are others that have spoken at meetings and conferences of the need for such information. Some countries—e.g., Guatemala and the Philippines—have worked hard to design systems to promote this sort of interface. Information workers are seen as having a key role to play in farmer to scientist communication (Gregorio & Sison, 1989; Bartolini, 1989).

Within the information sector specifically, AGRIS (Agricultural Research Information System, Rome, Italy) is designed to allow countries to have maximum control over their information resources, collected according to their national priorities, and without prejudice to level of development. AGRIS National Input Centers in 130 countries and in seventeen international and regional centers have agreed to select the literature of their country or region and submit it to produce the bibliographic database (in 1987, eighty-three countries were able to comply with this commitment). That database held 1.5 million citations at the end of 1987 and is growing by about 125,000 citations each year. Approximately 90 percent of the input is in machine-readable form. Since 1986, indexers have been able to work in French, English, or Spanish. AGRIS also produced outputs in all three languages (AGRIS, 1988).

Frequent meetings are held with all national centers to receive ideas and suggestions for the operation of the database. Copies of the bibliographic data that result from the national input are available on tape or on paper from the AGRIS Coordinating Center at FAO (Food and Agriculture Organization of the United Nations, Rome, Italy). These can be used in individual countries to forward the local objectives of the country's information sector. For example, Hesse de Polanco (1988) discusses the use of the AGRIS data for Mexico to generate local bibliographies on various commodities and to evaluate collections at university and research center libraries. For developing countries, AGRIS is one of the notable success stories.

In spite of that, there is no doubt that the AGRIS database is more accessible from the developed world than from the developing world whether online or in print (Lebowitz, 1986). It is also true that there are more publications from the heavily industrialized temperate countries than from the industrially developing tropical world, and more infrastructure for completing input to the database. Statistics alone indicate that, at any given moment, the potential exists to have more information from the temperate zones than from the tropics.

Furthermore, the more sophisticated countries want to access all the important agricultural databases. And they want to access the literature found there as well. This causes a double bind for both sectors. Even the provision of any information from the international sector may allow developing country administrations to neglect the need for a national information infrastructure. John Woolston has spent more than twenty years actively promoting information services to agricultural researchers in the tropics. He has been integrally involved with the establishment of sophisticated information services at the national, regional, and international level. He now says:

> I cannot help remarking that the IARCs [International Agricultural Research Centers—a generic term for all centers involved in that kind of research in the developing world] should have a well conceived strategy to encourage the development of libraries in the national institutions. Without such a strategy, there is a danger that the best-intentioned actions could be counter-productive. For example, when the IARC provides a needed service directly to national scientists, do those scientists come to rely on it and lessen any efforts they might have made to ensure better service from their own libraries? How can this be avoided? (Woolston, personal communication, June 12, 1989)

The questions above are asked from several different points of view but address a similar problem. What system, service, or technology can better serve the "resource poor" than the "resource rich?" What service can be provided from outside the country that will not change the nature of the information process within the country? Answers are not easily found. Stopping all international assistance to national agricultural research would be very unlikely to promote the development of different kinds of information systems unless other factors changed at the same time. Those factors are the very ones that define the publication, collection, storage, and dissemination of agricultural information in the tropics.

Problems Related to Geographical Isolation

There is considerable unanimity among national and international information workers about the problems that constrain agricultural information collection and dissemination in the developing world. A digest of the ideas of a representative group of information professionals is presented in Table 1, a table that attempts to group the ideas by common themes. This article's references section will provide more opportunities to study these problems and their individual manifestations in specific problems and regions. Some of the problems that confront librarians and documentalists in the tropics will seem very familiar to colleagues in all parts of the world—especially those that relate to resources. But the most universally present problem in any

TABLE 1
PROBLEMS AND CONSTRAINTS ENCOUNTERED IN AGRICULTURAL LIBRARIES AND INFORMATION CENTERS THROUGHOUT THE WORLD

Region or Country (correspondent or author)	Staffing/Training	Language
Sub-Saharan Africa (Hailu)	- Manpower is non-existent or inadequate. - Low morale - Loss of trained people to administrative posts	
Latin America (Barrantes)	Training of libns. is more technical than information-mgt. oriented.	
Malawi (Kinney)	- Low status library workers - Poorly trained staffs - Few career incentives	
Latin America (Siri)	- Deficiency of training opportunities.	
Pacific/Asia (Johnson)	- Only handful have trained staff to catalog & provide subj. access in English. - Status & pay are low	- English cataloguing - Usefulness of English materials sometimes dubious
ACP countries (Niang, Hartevelt & Dusink)		- More French materials needed.
Internat'l (AGRIS)	AGRIS has had to cut back on activities due to funding	- Producing Agrindex in Fr. Span. Engl. - AGROVOC thesaurus.
Internat'l (CABI)(Metcalfe)	- Staff training & career development important to staff.	
Argentina (Tuya)	- Too few staff but well-trained (in some urban areas); in ag., less trained. - Low status, value - Need a professional assn.	
Colombia (Lopera)	- Professional education doesn't cover all areas.	
Latin America (Malugani)	- Frequent changes in name & structure of unit-whether ministry, nat'l library or university - Loss of trained staff to other countries/professions (brain drain) - Need continuing education	
Ethiopia (Abraham)	- 38 staff for 11 ag. libraries, 9 professionals - Most staff not diploma holders - Need exposure to technology	
India (Bannerjee & Moitra)	- Average professional staff: 8.4 in ag. universities 2.2 in research institutes	
India (Ahsan & Lal)	- 1 staff: 153 users ICAR libs. - 1 staff: 244 users univ. libs.	
Sri Lanka (CGIAR meeting)	- Most staff at libraries do not have any formal educ. in library or info sci.	

TABLE 1 *(Cont.)*
PROBLEMS AND CONSTRAINTS ENCOUNTERED IN AGRICULTURAL LIBRARIES AND INFORMATION CENTERS THROUGHOUT THE WORLD

Region or Country (correspondent or author)	Staffing/Training	Language
Vietnam (Vo-Tong Xuan)		- Library exchange programs limited to English pubs.
Sahelian Region (RESADOC) Rpt.	- Coord. Ctr. is short of staff	
China (Pan Shuchun)		Computerization of Chinese -lang. materials needs bigger base of characters
Nigeria (Ibekwe & Azubuike) (NAALD)	Pervasive inadequacies of staff	- 98% of literature in sciences published outside Nigeria - Overdependence on foreign literature
Pacific (Foss)		- 700-800 indigenous languages of PNG still have no printed form
SE Asia (Syed)	- Inadequate staffing—barely adequate to carry out basic processing/admin. functions - Hard to maintain good morale among librarians	
Cameroon (Baldwin)	- Library training varies from 5th grade to MLS - No library school in Cameroon	
Zimbabwe (Matare)	- Lack of qualified staff - No courses in librarianship in recent years	
USA (Vavrek)	- Only 25% of full-time employees have MLS (professional degree) - Many 1-person libraries	
Australia (Sanders)	- Large number of rural librarians w/limited or no access to study, seminar, & training activities - Branch libraries staffed w/"nonprofessionals"	

TABLE 1 *(Cont.)*
PROBLEMS AND CONSTRAINTS ENCOUNTERED IN AGRICULTURAL LIBRARIES AND INFORMATION CENTERS THROUGHOUT THE WORLD

Region or Country (correspondent or author)	Standards	Urban Bias	User Education
Sub-Saharan Africa (Hailu)	- 94% of Ethiopian researchers say their libraries do not meet their info. requirements - Low govt. priority given to libraries		- Editorial and publishing facilities are luxuries
Latin America (Barrantes)			- Publishing funds aren't available so research doesn't get published - Relationship of user to info. specialist not well established; not one of collaboration
Malawi (Kinney)			- Low value on info. in society as a whole & in gov't.
Latin America (Siri)			- Users unaccustomed to info. svcs. and info seeking
Pacific/Asia (Johnson)			
ACP countries (Niang, Hartevelt & Dusink)			
Internat'l (AGRIS)	- AGRIS has taken action on stds., training info personnel to apply input stds.		Had to cut back on training
Internat'l (CABI)(Metcalfe)			
Argentina (Tuya)		- Libs. concentrate in urban areas - Ag libs. at research stations need service	Users don't have a consciousness of value of info.
Colombia (Lopera)	- Standards have been the area of emphasis		- University students totally unprepared - Efforts concentrated on tech. proc., not on pub. serv. - Need to train university professors to train students to use information
Latin America (Malugani)		- Need new kind of specialists to work with rural "silent majority"	- Not oriented to user services or bibliographic inst. - Govts don't perceive usefulness of info.
Ethiopia (Abraham)	- 11 ag libraries with space for 150 users		- Users do not show interest in materials
India (Bannerjee & Moitra)			
India (Ahsan & Lal)			
Sri Lanka (CGIAR meeting)	- Reorganized in 1982 for better utilization of space		- "Users do not show enough initiative to fully consume what is already available to them"

TABLE 1 *(Cont.)*
PROBLEMS AND CONSTRAINTS ENCOUNTERED IN AGRICULTURAL LIBRARIES AND INFORMATION CENTERS THROUGHOUT THE WORLD

Region or Country (correspondent or author)	Standards	Urban Bias	User Education
Vietnam (Vo-Tong Xuan)	- Abst. journals size causes problems in internat'l mail	- Declining funds to research - Funding is oriented to applied research	
Sahelian region (RESADOC Report)			- Only 20% of users are "at a distance" Most of these are from the US, Asia, & Europe. Demand from member states low
China (Pan Shuchun)			- Users need to know about services
Nigeria (Ibekwe & Azubuike) (NAALD)	- Inadequate buildings - Some buildings erected with no concern for tropical environments - Many "grand" bldgs. incomplete	- Wholesale adoption of Western model makes libraries suited only to the urban elite	
Pacific (Foss)	- Professionals want a voice in setting worldwide standards; want country names and authors included in authority lists	- Need to serve farm advisors, extensionists & farmers	
SE Asia (Syed)	- Basic library stds. almost non-existent - No budgetary stds.		- User svcs. invariably neglected; causes negative impression in users
Cameroon (Baldwin)			- Lack of administrative support
Zimbabwe (Matare)		- Most rural farmers are illiterate - Need non-print media	- Very difficult to teach the public to do searches
USA (Vavrek)			- Users don't see the need for academic training for libns.
Australia (Sanders)			

TABLE 1 *(Cont.)*
PROBLEMS AND CONSTRAINTS ENCOUNTERED IN AGRICULTURAL LIBRARIES AND INFORMATION CENTERS THROUGHOUT THE WORLD

Region or Country (correspondent or author)	Library Collections	Isolation
Sub-Saharan Africa (Hailu)	- Chronic foreign exchange problems - Almost total neglect of information sector	- Isolation from peers - Lack of info in fields of specialization - Only 2 African Libs. are members of AGLINET
Latin America (Barrantes)	- Access to non-conventional literature extremely limited - Materials budgets are inadequate	
Malawi (Kinney)	Donors don't support long-term costs, so collection support is weak	- Geographic - Cultural - Market Size
Latin America (Siri)	- Lack of support within nat'l institutions - Lack of funding	
Pacific/Asia (Johnson)	- Collections sporadic due to proj. funds that come and go	- Libraries work in isolation. Need tools to bridge the gap - Very limited exposure to most modern library practices
ACP countries (Niang, Hartevelt & Dusink)	- Need for databases & collection development	- Need to know where to get info.
Internat'l (AGRIS Participants)	- Need improved document delivery - Need financial support for coupon scheme	
Internat'l (Metcalfe)	- Libraries/information low priority even when aid is available - Foreign exchange problems	
Argentina (Tuya)	- Too little or nonexisting funding - Collections incomplete or out of date	"Isolated efforts & isolated actions" - Geographical isolation - Mail problems
Colombia (Lopera)	- Users don't know how to access info.	
Latin America (Malugani)	- Obsolete collection - Insufficient evaluation - Not enough "grey" literature - Govn'ts don't support collection building	- Growth of information sector only began in the 1950s - Users are isolated from each other - Geographic & telecom. isolation a problem
Ethiopia (Abraham)	- 22,160 books & journals serve 9,884 professional researchers - Foreign exchange a problem - World Bank gave $61,000 for materials	- Most library svc. is located in Addis Ababa - Not aware of linkages to info. sources
India (Banerjee & Moitra)	Average pubs. acqu./yr = 2895/yr. (ag. universities) 576/yr (research centers)	- Virtually nothing exists of information service at the national level - Limited translation services available on demand
India (Ahsan & Lal)	- Percent of institution materials budget ranges 0.1%-5.6% (mainly .12-1.6%) University: 48% journals. Research institutions: +-: 75% of materials budget spent on journals	

TABLE 1 *(Cont.)*
PROBLEMS AND CONSTRAINTS ENCOUNTERED IN AGRICULTURAL LIBRARIES AND INFORMATION CENTERS THROUGHOUT THE WORLD

Region or Country (correspondent or author)	Library Collections	Isolation
Sri Lanka (CGIAR meeting)	Cent. Lib. of Dept. of Ag. Collection= 20,000 vols., 110 current journals & "a rich collection of early botanical & agric. literature." Can't get foreign exchange	
Vietnam (Vo-Tong Xuan)	- Can't get foreign exchange - Can't get all local pubs.	
Sahelian Region (RESADOC Report)	- No money to support nat'l centers - No money for infrastructure	- Lack telecommunications - Lost financing of newsletter
China (Pan Shuchun)	- Common problem = limited budget - Rising price of publications - Duplication & missing titles - Different levels of access by region	
Nigeria (Ibekwe & Azubuike NAALD)	- Foreign exchange problems - Arbitrary budget cuts in time of financial difficulty	- Little coop. among libraries - Little central planning - Libraries don't collect local publications - Telecommunications limited
Pacific (Foss)	- Getting copies of articles from DCs is "a nightmare" - Foreign currencies are hard to come by	- Pacific nations are geographically isolated - Professionals are intellectually isolated
S. Asia SE Asia (Syed)	- Currency exchange makes foreign materials "astronomically" expensive - Budgetary allocations very low; based on dept. heads' attitude toward library	- Librarians rarely involved in planning - "Isolation of library from the mainstream of organizational activity" - Institutional rivalries limit cooperation
Cameroon (Baldwin)	- Combined univ. holdings = 9000 vols. in 1985 - Problems with journal subscriptions	- Defunct professional organization
Zimbabwe (Matare)	- Largest ag library (Ministry) has 5000 books, 11,000 journals, 10,000 pamphlets - Ever-increasing costs of literature combined w/ massive budget cuts. No longer able to provide up-to-date info.	
USA (Vavrek)	- National av. budget for rural libraries is $30,000/yr. (all expenditures)	
Australia (Sanders)		- "The tyranny of distance" - Isolation from professional colleagues - Geographical distances result in high freight costs & high telecommunications costs

TABLE 1 *(Cont.)*
PROBLEMS AND CONSTRAINTS ENCOUNTERED IN AGRICULTURAL LIBRARIES AND INFORMATION CENTERS THROUGHOUT THE WORLD

Region or Country (correspondent or author)	Insufficient/ Inappropriate Technology	International Bias	Other
Sub-Saharan Africa (Hailu)	- Equipment goes to waste because spare parts unavailable - Lack of equipment in general		- Project - funded support short-lived & local commitment to sustain services & facilities lacking - Duplication of svcs. from IARC's
Latin America (Barrantes)			- Lack of nat'l info. policy impedes an orderly, coherent development
Malawi (Kinney)	- Computers are newly appropriate with advent of PCs	- Internat'l info structures differ from local ones: • Reliance on indiv. experience; • Reliance on verbal info. - Dependence on donor agencies results	
Latin America (Siri)	- Sometimes focus on technol. & not on solving the problem - Not enough info avail. to make decisions - Rapid change in technologies	- Well-meaning entities focus on technology transfer without considering the social environment	
Pacific/Asia (Johnson)			
ACP countries (Niang, Hartevelt & Dusink)		- Almost no d-bases are located in developing world	- Need to market services of the networks
Internat'l (AGRIS Participants)	- Need support for CD-ROM project		
Internat'l (Metcalfe)			
Argentina (Tuya)	- Inadequate equipment		
Colombia (Lopera)			
Latin America (Malugani)	- Most inst. totally unprepared for the "information society"	- 75% of communic. industry is in the hands of 80 transnational entities - Fear of technological dependency	
Ethiopia (Abraham)	- Ministries have only 1 typewriter for 4 libraries - IAR has more equipment - Spare parts difficult to find	- Less than 1% of d-bases are in the developing world	
India (Banerjee & Moitra)			

TABLE 1 *(Cont.)*
PROBLEMS AND CONSTRAINTS ENCOUNTERED IN AGRICULTURAL LIBRARIES AND INFORMATION CENTERS THROUGHOUT THE WORLD

Region or Country (correspondent or author)	Insufficient/ Inappropriate Technology	International Bias	Other
India (Ahsan & Lal)	Only a few libraries are computerized, but movement in that direction		- Quotes Parker list (1971): "not as gloomy" now but many still hold true - Yearly produce 900-1,000 monographs & 500 research reports - 1,500 ag. biol. serials in India languages - 25,000 research papers in English —Coverage of no more than 10,000 refs. in all dbases
Sri Lanka (CGIAR meeting)			- NAL had to stop providing photocopies, BLLD very expensive . This has impacted Sri Lanka network's doc. delivery systems
Vietnam (Vo-Tong Xuan)	- Training in info technology is needed		
Sahelian Region (RESADOC Report)	- Lost funding for preventive maintenance of equipment		- Not all members can comply with input commitments - Lack motivation, money, communication resources
China (Pan Shuchun)			
Nigeria (Ibekwe & Azubuike NAALD)	- Technological gap is growing - Librarians argue: books or computers?	- There is scarcely any bib. control of Nigerian lit. Internat'l d-bases overlook this lit unless it is published outside Nigeria (i.e., in US, Europe)	- Nigerian AGRIS input center docs not input Nigerian literature - Nigerian publications are usually issued late
Pacific (Foss)		- CABI, AGRICOLA & AGRIS don't include Pacific publications that are most pertinent - Need for a Pacific Islands Index	
S. Asia SE Asia (Syed)	- LDCs segregated, by default or design, from mainstream of technology	- Exploitative nature of DC/LDC interface weakens economies - Pricing of publications is based on marketing systems in DCs	- Government pressed by many needs don't see libraries as "affordable" - Great diversity in libraries in this area
Cameroon (Baldwin)			
Zimbabwe (Matare)	Printing facilities are inadequate	- Rely on CABI - Because of for. exchg. limitations, can't get all info. needed	- Formation of National Library Documentation Service does not include agricultural information.

TABLE 1 *(Cont.)*
PROBLEMS AND CONSTRAINTS ENCOUNTERED IN AGRICULTURAL LIBRARIES AND INFORMATION CENTERS THROUGHOUT THE WORLD

Region or Country (correspondent or author)	Insufficient/ Inappropriate Technology	International Bias	Other
USA (Vavrek)			- An eroded tax base and the end of federal funds has left rural libraries strapped for funds
Australia (Sanders)			- Great diversity in size of libraries and services offered

discussion of information work in the developing world is one less frequently found in the heavily industrialized world. That problem is isolation.

Isolation has profound consequences for information work in the developing world. Virtually every article, every personal communication, every casual discussion about libraries and information centers and the problems they confront finally reaches the point where the word *isolation* best defines the problem. Kinney (1988) has written a succinct and informative discussion of the problems that information centers face, addressed in terms of "information isolation." She includes many issues discussed later as well as others. She summarizes:

> Many single factors of information isolation...exist in areas that would not be defined as information isolated, and information isolated areas can exist within information rich areas. An information isolated area, however, is characterized by a convergence of the factors..., which occurs most often in poor countries or poor and isolated areas within more highly developed economies. This convergence is defined as information isolation when it hampers the growth of an information infrastructure adequate to meet the requirements of the society to function efficiently in meeting the needs of the individuals that comprise it.

Agricultural information specialists deal with geographical isolation both at the international and the national level. Not only are workers separated by long distances and territorial borders, but impassable terrain, water barriers, and other geographical features render even short distances problematic. The lack of a fully developed infrastructure for transportation, mail, freight, and telecommunication is characteristic of the developing world. In some countries the infrastructure exists but does not extend much beyond the principal cities.

Effect of Marketing and Distribution on Collection Building

The first place an outsider is likely to notice the effects of international geographical isolation is in the development of library collections. There is only very limited access to information about bibliographic sources and new publications.

International publishers do not aim their direct-mail marketing campaigns at agricultural libraries in the developing world. There are few booksellers and agents for distribution in the tropics because the difficulty of importing and exporting books makes it an unprofitable business in any but the very large countries (e.g., China, India, and Brazil) or where the subjects have a very broad based appeal (sex, scandal, technology, finance). Without advertising and marketing, most books and periodicals remain unknown even to librarians.

Next, reference and acquisitions tools such as directories of published works in print and ISBN directories are not widely available, nor are the library journals that carry book reviews and advertising. Since many important publications are virtually unknown in the developing world, it is difficult for librarians to identify the best purchases, even where funding may be provided, from the national government of the country or from an international source.

Even where free or highly subsidized publications are available, there is a lack of information about where and how to obtain these. Ironically, many agricultural research institutions and many information centers keenly wish to reach audiences in the developing world and yet are also suffering from a lack of information about how to reach these audiences. Marketing without a marketing infrastructure is a difficult business.

It is certain, however, that geographical isolation can be reduced by improved availability of reference tools. Azubuike's (1988) paper for the Nigerian Association of Agricultural Librarians and Documentalists (NAALD) addresses the availability of appropriate publications. It spells out a number of international sources for publications in agriculture. Other sources of free publications also exist. Olade (1988) and Ibekwe and Azubuike (1988b) list some of these. The United Nations (U.N.) has published a guide to U.N.-related information sources (ACCIS, 1988). Niang, Giovanetti, and Hamilton (1989) have published a guide to information sources in African, the Caribbean, and the Pacific (ACP) countries, and Niang's articles (1988a, 1988b) discuss further information sources for that area. More reference tools are in production. The International Association of Agricultural Librarians and Documentalists (IAALD) has published a worldwide directory of agricultural information centers late in 1989. And the Butterworth's guide to information sources for agriculture (Lilley, 1981) is under revision and will be published in the near future.

There are also organizations that assist developing country libraries to obtain agricultural information from the rest of the world. NAL had a program (called AID-Update) in the 1970s and 1980s to provide photocopies of agricultural literature to information centers in the developed world. The African Agricultural Literature Service of CAB International currently supports free literature for some member countries (Bellamy, 1988). Additionally, some organizations—for example, the Nitrogen Fixing Tree Association (NFTA), Waimanalo, Hawaii, have plans that allow members to make contributions to a fund that subsidize memberships for others who cannot obtain foreign currencies or cannot afford membership dues (Willers, 1989). However, due to geographical isolation and the fact that these services and plans are generally unmarketed, most libraries do not have the information to take advantage of them.

Even when an agency is dedicated to marketing to the developing country institutions, it is not easy to find the methods to do it. The CGIAR routinely publishes a joint catalog of publications, available from any of the CGIAR centers or from the secretariat in Washington, D.C. Most of these publications are free, in limited quantities, to researchers and libraries. IRRI (the International Rice Research Institute, Manila, the Philippines), has led the way for the international centers, trying to find the best ways to let potential clients know how to obtain these publications. Other international centers, such as WINROCK International, Petite Jean, Arkansas; CIAT (Centro Internacional de Agricultura Tropical, Cali, Colombia), and ICRISAT (the International Center for Research in the Semi-Arid Tropics, Hyderabad, India) have also been very active in this effort.

Influence of Geographical Isolation on Acquisitions

Compounding the difficulty of finding out what is available is the fact that international acquisitions are very difficult. Most developing countries sharply limit the availability of foreign exchange in an attempt to keep the balance of payments from becoming insuperably negative, and only the highest priority purchases are allowed. There are very expensive surcharges for international orders. To begin with, each foreign exchange transaction carries a bank charge. Banks will only accept payment in certain currencies and from banking systems that they do business with. This causes considerable delay as well as expense.

Even in countries where actual availability of money is not the problem, internal bureaucratic procedures in public sector institutions can make acquisitions work very complicated. The procedures are fairly complex and inefficient to begin with due to the understandable desire of institutions to retain control of their finances under conditions of administrative instability (that is, frequent job changes among top administrators). Various signatures and permissions are required for each purchase. Furthermore, the procedures are not always computerized so the record-keeping for these systems of fiscal checks and balances is also complex.

Once the materials are ordered, there are more problems of geographical isolation to deal with. Freight and mail charges are very high, and both delays and damages are often encountered in the process of shipping. Any materials not shipped in heavyweight or very sturdy containers will arrive severely damaged. Shipping by surface mail will cause routine delays of six to eighteen months even when no problems are encountered. Air mail is very expensive but is the only effective way to mail library materials internationally.

Finally, not all items make it through customs in every country, and that can be an additional problem. Some countries do not allow any materials to enter their borders if these mention, by name, a country with which they have a political dispute. For example, in the mid-1980s, China required any publication that referred to Taiwan as China be censored. Currently, some Arab countries are not allowed to receive materials from Israel. The United States has routinely opened packages of library material arriving from Colombia during the late 1980s. In the late 1970s Indonesia blacked out, with marking pens, offensive political and cultural references. And, while books are not particularly valuable commodities on the resale market, some are stolen, especially if they have attractive color photos. Videotapes and computer software have low survival rates in the mails.

Effect on Scientific Journal Subscriptions

Access to journals is also very limited, owing to the small budgets for foreign journals. Also, journal publishers are difficult to locate without guides to periodical literature and similar tools. Maintaining subscriptions and handling claims is a complex business when there are shipping delays of up to eighteen months. Such work requires very intensive record keeping and the staff resources to go with it. Subscriptions are also subject to periodic abrupt cancellations when bills go unpaid (because they were not received) or messages (updating mail lists, for example) are not responded to for excessive lengths of time.

Access to Databases

Many developing country scientists and libraries and information centers that serve them try to avoid the problem of inadequacy in periodicals collections by obtaining copies of specific articles of interest. Unfortunately, locating articles in journals is also difficult when an institution is geographically isolated.

The online and print products of the three biggest international databases for agriculture (CABI, AGRIS, AGRICOLA [Agriculture Online Access from NAL]) are available on a limited basis in the developing world. The printed versions of databases are more accessible. All three databases and some smaller more specialized ones are furnished to libraries and information centers through special project funding from international organizations, but this availability usually lasts only as long as the project.

CAB Abstracts are available in libraries in countries that are Commonwealth members, and now that CABI is an international institution, non-Commonwealth countries can also become member institutions and acquire the abstract journals through that route. A few wealthier institutions in non-Commonwealth countries also purchase the CABI abstract journals or some part of them.

AGRINDEX (the printed version of the AGRIS database) is available to the National Input Center in every country that inputs bibliographic citations. Often the index will be held by only that one library in the whole country, but in some countries additional copies will be purchased.

Since travel is difficult and expensive, and telecommunications and mail services may be inadequate, the limited number of copies of a printed index or abstract journal has a very negative affect on the number of users able to have access to it. Some countries do have online access to the computerized database hosts, whether through DIALOG in Palo Alto, the United States, DIMDI (the computer of the Deutsches Institut für Medizinische Dokumentation, Cologne, FRG), or IAEA (International Atomic Energy Agency, Vienna, Austria, which mounts the AGRIS database). Libraries with sufficient funds can access whatever databases they might find useful in these countries. Obviously, however, such access is quite expensive since it involves international telecommunications charges as well as the charge for the service. Furthermore, there are a number of countries where telecommunications access is denied altogether—usually for political reasons that have nothing to do with agricultural information work.

Access to Grey Literature and Individual Documents

Nonconventional or "grey" literature (such as articles from conferences, annual reports, technical bulletins, or individual copies of printed articles) is extremely important in agriculture worldwide (see, for example, discussions in Chillag, 1982; Lancaster & Beecher, 1981; Sattar & Lancaster, 1984). This literature is even more important in the tropics (see Aina, 1987; Metcalfe & Cooper, 1982; Monge, 1979; Posnett & Reilly, 1986). Substantially fewer books are published in the developing world than in the United States or Europe. This is partly due to market size, geographical and political factors, and to cultural factors such as language. It may also relate to the fact that scholars have been creative in inventing lower cost alternatives to books—class handouts created by professors, annual reports, or papers generated for conferences and symposia. These typed or duplicated manuscripts are considered to be publications and, indeed, are extremely valuable information sources in spite of their informal look. These publications are much more economically feasible than books.

Almost all agricultural research is published in these inexpensive formats. For example, pasture grass researchers in Colombia, surveyed on where they published research, responded (Harris, unpublished data): 100 percent published in institutional reports such as annual reports or progress reports; 66 percent published as a part of a conference proceeding; 36 percent published newsletter articles; 43 percent published in a national journal; 14 percent published in a foreign journal;

and 5 percent published in a book. The Cassava Information Center at CIAT, which collects all cassava documentation, shows a similar pattern in its collection (López, 1980) (see Eres & Bivins Noerr, 1985, for an analysis of scientific publishing).

Given the difficulty that developing country libraries experience in obtaining supposedly easy to obtain materials like books and journals, the frustrations they encounter in seeking out and obtaining nonconventional literature are not as noteworthy as they are for libraries in the heavily industrialized world. Many institutional publications can be obtained, without charge, from the author or institution involved. Granted that only a few copies are likely to have been published, at least the developing country library has an equal opportunity to obtain one of them. Photocopies or reprints of journal articles are also obtainable from authors, and many developing country information centers are based on the collection of individual conference papers and journal articles rather than on books and bound journals. This partially explains the popularity of "pages of contents services" (services that produce copies of contents pages of journals, proceedings, bulletins, and other publications and circulate them to an institution's scientific personnel (see Cooney et al., 1988; Harris, 1985a,b).

In fact, due to the broad use of systems of library exchange, the developing country library will probably have a better chance of obtaining nonconventional literature than the library or information center in a more developed country. Some U.S. libraries have discovered this fact and used it to build their collections of development-related materials while also helping the developing country library to obtain materials that might be difficult to find locally (Schenck-Hamlin & Foss, 1986).

For developing country libraries and information centers fortunate enough to have funds for national or international mailing, library exchange is the main method of developing collections. It is a labor-intensive process and thus limited to libraries with reasonably sized staffs, but it is a way to build a collection in a library without much money.

The payment for the document is still a problem even though the system is based on an exchange of publications. Even postage can be hard to obtain since institutions do not budget for international mailing, and national mailing is handled through franked mail. That is why coupon schemes and other projects to support mailing costs and facilitate document delivery and interlibrary exchange have so much appeal for libraries in the developing world (Bellamy, 1988; Smith, 1987; Syed, 1981; Wood, 1988).

The experience of CABI with the African Agricultural Literature Service shows, however, that a long growth curve must be planned, even for the best projects, in those parts of the world with the weakest infrastructure. This project was to provide free SDI (Selective Dissemination of Information) searches and document retrieval to CABI member countries in Africa. Responsibility for local arrangements was left entirely up to country representatives. Response was generally positive, but CABI felt that progress was disappointingly slow (Bellamy, 1988).

Since the infrastructure of document collection and document exchange already exists in most parts of the developing world, and since this kind of information activity is entirely compatible with the cultural environment of the countries themselves, much headway can be made with small investments in support of these activities. AGRIS has tried for several years to implement a coupon scheme, thus far without success. It is hoped that this plan will soon be funded (see AGRIS, 1988).

Geographical Isolation at the National Level

Not all of the isolation that causes problems for developing world libraries and information centers is due to distance from the developed world. At the national level, geographic isolation is still a factor. It is difficult to overstate the levels of wealth that a country requires before highways are well developed especially in rural areas; before trains and planes are commonplace; before electricity and telephones are commonplace and fully functional; before mail can be delivered far outside the cities; and before the many other mechanisms are in place to shrink the distances between one place and another. Countries that are striving to feed their populations and provide basic social services have to place priority on the most fundamental activities, and progress in the communications infrastructure is not usually the top priority. Nonetheless, the lack of a communications and transportation infrastructure contributes significantly to the problems that developing country information workers have to deal with every day.

OTHER TYPES OF ISOLATION AND INFORMATION TRANSFER

In looking at the problems caused by isolation, it is important to realize that some problems associated with isolation have nothing to do with geography. For example, professionals in the developing world are often intellectually, organizationally, and culturally isolated.

Intellectual Isolation

First, there is a real shortage of university programs to educate librarians, and some of the existing programs are outdated. Continuing education programs are in even shorter supply (see, Arboleda-Sepulveda, 1986; Paz de Erickson, 1986; Syed, 1981). Professional associations exist in most countries, but not all librarians can afford to belong or travel to meetings. This has a negative effect on the programs that the associations can support.

Institutional rivalries can further exacerbate the problems of intellectual isolation. It is not unusual for several government agencies to have overlapping responsibilities for the agricultural sector. Sometimes one agency will not collaborate fully with other agencies. Universities may compete with each other and with government agencies for recognition. This sort of competition is common in the developed world, and there too it causes many problems. But for librarians already geographically isolated from peers, it is unfortunate when institutional factors keep them from working together.

Another factor in intellectual isolation is the distance between different specialists within the agricultural information profession. One of the ramifications of the developing world's publishing style is the development of several partially polarized spheres of agricultural information work. There are librarians, some of whom have university degrees in library studies. Some librarians have university degrees in library science but many have only on-the-job training or training from one or more short courses in service areas. Certified librarians will have studied technical processes but rarely user services (Lopera, 1988; Malugani, 1984). Librarians deal mainly with books and periodicals and with occasional publications such as newsletters and brochures. In many countries, librarians have low status regardless of competence level.

There are also subject specialists with university degrees in the sciences but no training in librarianship. These specialists often have training—on-the-job or in short courses—in abstracting, indexing, thesaurus design, database design, and related areas. They are usually called documentalists in the European tradition, but in some areas the more common term from the United States has been adopted—i.e., information specialist. The documentalists have more status than librarians, at least with the agricultural researchers, because of their science education. Documentalists deal primarily with papers from conferences; all or pieces of annual reports, brochures and pamphlets; research reports; newsletter articles; and other difficult to obtain formats. They also deal with reprints and photocopies of individual journal articles. Since journal subscriptions are so expensive, these are in very great demand.

A great deal of editing and management of purely scientific publications falls to the librarians and documentalists. Distribution of institutional publications is also a frequent library task.

There are also communication specialists or agricultural communicators. They are principally involved in writing and editing agricultural publications and in mass media production. Some produce slide sets or other training materials. In government institutions, those communicators involved in public relations have the better paid and more prestigious positions. Sometimes editing and publishing scientific papers also falls in this sphere as does distribution.

In spite of the overlap in service areas, each of the groups tends to keep separate and think that the principal work of their group the most important part of the agricultural information cycle. There is also a limited amount of communication among specialists in various groups, and cooperation.

Specialization also influences the relationships between agricultural information workers and other information workers—e.g., in the health sciences or even in general biology. The net result of this separatism is that agricultural information workers are professionally isolated.

In some of the more sophisticated research and extension environments, the awareness has developed that the information generated through research must reach the farmer for real gains in agricultural productivity. It is essential that research and extension work together in a multidisciplinary effort to accomplish outreach to the farmer. The participation of other disciplines, such as rural sociologists, has also proved to be of major benefit. Librarians, documentalists, and communicators have essential roles to play on multidisciplinary agricultural extension teams, but they have to overcome their isolation to fully realize their potential.

Organizational Isolation

Related to the intellectual isolation and rivalry at the interinstitutional level is the overall organizational isolation of the information worker in the developing world. First, most libraries are located in major urban centers and are isolated from rural users. (It is also the case, however, that most agricultural researchers and extension workers are located in the same urban areas.)

In a situation not unique to the developing world, there is virtually no communication between planners for agricultural development and the constituencies being planned for (Broadbent, 1989; Crowther, 1984b). And so the library suffers from the institution's lack of understanding of its audiences and what their needs are.

The library staff cannot explain to planners exactly who the library users are either, nor can they show planners and institutional administrators how library services influence the development process (Metcalfe, 1989). This is partially due to the fact that the low status of libraries and librarians in countries with very underdeveloped publishing industries prohibits any meaningful conversation between librarians and decision-makers. The library is very isolated within the organization. But the inability to communicate in terms that administrations can understand is also due to the fact that information workers have not evaluated or quantified the use of the information they provide (International Development Research Centre [IDRC], 1984; Metcalfe, 1989). They are barely able to keep up with the most critical processes and services, and the time to do institutional research is unavailable. However, the keeping of solid statistics seems to be growing in popularity.

Cultural Isolation

Cultural isolation of agricultural information workers in the developing world springs from some combination of the small market size of the individual countries and a certain bias toward the languages, cultural mores, technologies, and even the crops of the developed world. It has three principal effects on information work.

First, while researchers need to publish and read tropical crop information, they also need access to research on temperate crops. The reverse has not typically been true. (With the growing interest in crop diversity, this may not be the case in the future.) This puts an additional burden on information systems in the tropics (Azubuike, 1988; Cooney et al., 1988; Foss, in press; Ibekwe, 1988; Ibekwe & Azubuike, 1988; Metcalfe, 1984; Monge, 1979; Montaño de Mayolo, 1987; López, 1980; Vo-Tong, 1989).

Second, the publishing of research tends to be heavily centered in reports and occasional publications rather than in journals or books. This creates a situation in which information specialists must deal with the problems of collecting and disseminating nonconventional or grey literature. Nonconventional literature is not accorded the status of full bibliographic treatment in some agricultural databases. Even AGRIS, which greatly encourages the submission of nonconventional literature, is not able to obtain the majority of it because the distribution and bibliographic control of the literature itself, at the national level, is inadequate (see Aina, 1987; Chillag, 1982; Ibekwe & Azubuike, 1988a; Metcalfe & Cooper, 1982; Monge, 1979; Posnett & Reilly, 1986; Sattar & Lancaster, 1984; Chaudhry, 1987; Wood, 1988).

Third, information workers and users alike are forced to deal with English as well as one or more additional languages if they wish to participate in the full spectrum of agricultural research. This creates problems for the scientist—e.g., publishing outlets may be sharply limited if he can't express himself adequately in English. If unable to read English, his access to much of agricultural scholarship will be constrained. It also creates problems for the information specialist. The cataloging and classification of materials in English is problematic for people who speak or read one or more other languages better than English (see Ballantyne, 1989, for a full discussion of the problems associated with English *versus* local languages in Thailand. Much of the discussion applies to English *versus* other languages. Although French and Spanish are international languages, speakers of those languages still have to contend with the dominance of English in scientific publishing).

The Current State of Affairs

Having examined a number of problems that information workers in the developing world have to deal with, it may be useful to look at the particular situation of this sector in 1989. The 1980s brought hard times for agricultural libraries in all parts of the world. This is no less true in developing countries.

There is growing recognition of the need for agricultural research and, therefore, for agricultural information. While there are still many decision-makers and administrators who do not support information-related activities, others have realized that agriculture is the very basis for developing country economies, and that information is necessary for good research. It is unfortunate that this realization coincides with a shortfall in international support. While the reduction is not absolute, there is no doubt that funding levels have been sharply reduced from the mid-1970s. To further complicate the picture, developing country economies are stressed by international debt and low oil prices. The ability of countries to support luxury programs, such as libraries, is much reduced.

Fortunately, much of the good work done in the 1970s and the early 1980s has provided a structure of trained personnel, core collections, information technologies (computers, databases, etc.), and formal and informal networks, that continues to carry the profession forward even through times of stress.

As an example of the difficulties faced at the beginning of the 1990s and the gains of the 1970s and 1980s, a brief account of the activities of Latin America and the Caribbean is given later. Much more information at the country level is available from the reference list (see, for example, the references marked with an asterisk).

Latin America and the Caribbean

The 1970s saw rapid growth in agricultural research and in formal information networks in Latin America and the Caribbean. The biggest of the agricultural information networks, AGRINTER (Sistema Interamericano de Información Agricola, headquartered at Coronado and Turrialba, Costa Rica), served the whole region (see Elso, 1989; IICA, 1978; Molestina, 1988; Pratt i Trabal, 1988; Arias de Guerrero, 1987).

One of the principal parts of AGRINTER was a printed bibliography *(Indice Agricola para América Latina y el Caribe)* and its online counterpart—a computerized database for agriculture in Latin America and the Caribbean. These were produced at IICA/CIDIA (Instituto Interamericano de Cooperación para la Agricultura/Centro Interamericano de Documentación e Información Agricola, Coronado, Costa Rica), the coordinating center for the network. Regional products were free to the national input centers and were inexpensive for other users. The low cost made it possible for many institutions to have access to the national bibliographic resource for the first time. Between 1975 and 1986, a total of 146,604 references were processed as part of the AGRINTER database (Molestina, 1988).

While AGRINTER was a formal network in its own right, it also served as a regional affiliate of AGRIS, preparing and/or compiling the computer-readable input for the AGRIS database. As a result of the work of the AGRINTER network members and the support of the AGRIS Coordinating Center and the Input Center, the AGRIS database of bibliographic records grew to contain many regional records. This made it possible for people in other parts of the world to know what research was being conducted in Latin America and, to a lesser extent, in the Caribbean—another first for the region.

The database and bibliography weren't the only important results of the network, however. The regional meetings of the AGRINTER network were held yearly, each time in a different country. These provided an opportunity for network members to exchange professional ideas, to improve the work of the network, and to trade publications. The meetings also provided an opportunity for the members of the professional association for agricultural information workers in the region, AIBDA (Associación Interamericana de Bibliotecarios y Documentalistas Agrícolas, then headquartered at Turrialba, Costa Rica), to assemble and plan the association's activities for the next time period. Local professional affiliates of AIBDA were begun or strengthened, and local resource sharing networks were implemented in most countries of the region (Marquez, 1986).

Most countries also made progress on controlling their national agricultural bibliographic resource as an off-shoot of AGRINTER activities. Several countries had international funding for small and large national agricultural information projects such as collection building, equipment purchases, and computerization. Brazil, at that time well-funded nationally and internationally, built up a very impressive set of systems and services (Chapin, 1978 for a description of the Brazilian system in 1975 as seen through U.S. eyes, and Betioll & Bahia Margalho, 1980 for a view of the situation in 1980 through Brazilian eyes) as did Mexico and Cuba. Chile, Argentina, Colombia, Costa Rica, Panama, and others also made significant improvements in agricultural information infrastructures and developed excellent information services.

Another major outcome was that the human resource base of the region was greatly strengthened. Training courses were given by IICA/CIDIA—many with AGRIS and FAO support. IDRC provided funding to assist with these and other courses—e.g., those at CIAT. (It is scarcely possible to sufficiently acknowledge the support IDRC has provided to the agricultural information sector in the developing world as a whole. The financial support of the Information Division of IDRC has sponsored most regional and global agricultural information projects, numerous specialized information centers, countless training opportunities, and a great many conferences and workshops. Support to minicomputer, microcomputer, and microfilm technology has included software development, training, and database production, and has been instrumental in the spread of those technologies. IDRC currently supports the implementation of CD-ROM technology for developing countries. Many donor institutions have provided much-needed financial assistance to the developing world information sector, but

IDRC deserves a special vote of thanks.) Training opportunities were also provided by national institutions in many of the countries. IICA training alone expanded the human resource base by hundreds. Between 1974 and 1984, IICA offered 101 various training opportunities providing training for more than 1,700 professionals from nineteen countries (Molestina, 1988). The effect of increased funding can be seen by comparing this total to that for the period from 1955 to 1959, for example, with 13 students trained, or 1960-1970, with 76 students trained at headquarters, and another 121 trained in country courses (IICA, 1978).

The network, the meetings, the training courses, and AIBDA were all heavily subsidized by regional and international donors. But the energy and enthusiasm of the information sector at the national level was the key. Without this professional effort, none of the progress would have been possible. The international funding provided the means by which professionals in each country could realize the potential inherent in their organizations (see Arias de Guerrero, 1987; IICA, 1978; Malugani, 1984; Marquez, 1986; Molestina, 1988; Monge, 1979; Pratt i Trabal, 1988).

Simultaneously, libraries and information centers that were not internationally funded were springing up in many countries. Malugani (1984) cites questionnaires (with admittedly imperfect data, but faithfully representing the trend) showing the increase of agricultural library and information units during the 1970s—Argentina (38 to 95 units); Brazil (59 to 141 units); Colombia (18 to 40 units); Mexico (17 to 60 units).

Latin America and the Caribbean

In 1989, the agricultural information scene has changed in that Latin America is in difficult economic straits and international funding has been cut back as well. Collection building has been stalled for most agricultural libraries, and the growth of the sector is static.

AGRINTER has stopped functioning as a formal network. IICA/CIDIA is no longer the AGRINTER Coordinating Center, inputting data to AGRIS and has stopped the preparation of the regional bibliography. IICA/CIDIA concentrates its efforts on specialized information centers that support research funded by the institution. The institution also continues to support training efforts and other information activities.

Latin American countries now send data directly to AGRIS and thus have access to national, regional, and international bibliography. Cost is an issue, however, since the subsidies for these products are no longer available except in the Caribbean. While a few countries never became fully functional in bibliographic production, most of the national centers are fully capable of doing the AGRIS input work. There are trained staff, and the centers received considerable equipment during the good years. (This situation may not last forever, though, since the attrition of trained information personnel is noteworthy, and equipment does have a limited life.) Venezuela, Honduras, Guatemala, Mexico, Costa Rica, Chile, Brazil, and Peru currently publish national agricultural bibliographies, and maintain their own bibliographic databases.

In the Caribbean, agricultural information still has some international support. CTA (the Technical Center for Agricultural and Rural Cooperation, Wageningen, the Netherlands) has several projects in that region (Training documentalists..., 1989). The U.S. Information Service (USIS), Washington, D.C. and the U.S. Agency for International Development (USAID), Washington, D.C., provide some support. Additionally, IDRC support is still in evidence. CAGRIS (Caribbean AGRIS), the Caribbean regional database that represents the regional subset of the AGRIS database, is a welcome development, providing the structure for the management of agricultural information (Hee Houng, 1989; M. Hee Houng, personal communication, June 16, 1989). CAGRIS has the potential to help the Caribbean more than AGRINTER did since AGRINTER was heavily oriented to Spanish and Portuguese, whereas CAGRIS is multilingual to the same extent as the islands themselves. An impressive fisheries information service has also been started in Trinidad and Tobago. This service will produce extensive numeric data on the weather, the fish catch, market prices, and a bibliographic information database is also included (Trinidad..., 1989).

Trinidad, Jamaica, and Guyana have progressed more than the rest of the Caribbean. Trinidad especially, with the CAGRIS project headquarters, at the University of the West Indies Library (St. Augustine, Trinidad, and Tobago), and the CTA Regional Office and the Faculty of Agriculture also at the University of the West Indies, has the advantage. However, agricultural information activities in the Caribbean are still at a very low level compared to most Latin American countries (see Antigua and Barbuda, 1988; Grenada, 1988; Jamaica, 1988; Martinez, 1988; Matthew, 1988; Morean, 1988; *St. Vincent and the Grenadines,* 1988).

The professional association, AIBDA, is still active, and it is around the nucleus of AIBDA activities that the informal network that was once AGRINTER still rallies. IICA/CIDIA still subsidizes the work of AIBDA by supporting the executive secretary with salary, office space, and operating expenses. Without that support, the association might not survive since the dues are very low ($10/year). Since AIBDA has regional representatives in most of the countries of the region, and since the regional affiliate organizations of AIBDA are active, although most of them are underfunded, the contacts between professionals remain viable (AIBDA, 1989; AIBDA members, 1989).

Professional interaction is currently at a much lower level than it was ten years ago. Not many people are able to get to meetings now.

Even the triennial conference of AIBDA—always held in one of the countries of the region—can be an expensive proposition. In 1989, the AIBDA Executive Committee found itself searching for support to help its members attend its next conference held in Cali, Colombia, in May 1990. AGRIS meetings in Rome are almost impossible for Latin American and Caribbean members to attend. At the last consultation meeting of the AGRIS participating centers, the absence of the Latin American group was noteworthy and prompted a recommendation from the countries that donors provide support for participants' travel (AGRIS, 1988).

Since the United States has withdrawn support from the U.N., FAO budgets are under pressure and AGRIS has financial problems. Even the AGRIS information bulletin *(Agricultural Information and Documentation Systems, AIDS)* has not been produced since early 1988. The lack of this bulletin further reduces communication among professionals.

AGRIS has spent a great deal of time and effort in keeping member countries involved in procedures and policies. It has also created French and Spanish versions of the database to enable members to take full advantage of the products of AGRIS. These are important efforts in Latin America and the Caribbean. But without adequate funding for AGRIS activities, progress on that front is very slow.

The meetings, conferences, bulletins, and personal interaction that have resulted from networking have been very important for the agricultural information sector and thus for agricultural research. If the isolation that plagues the information professional in the tropics is to be reduced, the situation demands opportunities for professional interchange. Donors should pay attention to this need before all work done on the building of the information infrastructure is lost. Obviously donors cannot provide long-term support to any one organization or group. They can support an occasional meeting so participants can renew relationships and meet new colleagues. Donors could get maximum value for their investment if they also provided small amounts of money for mailing and shipping and for small-scale meetings, seminars, and professional activities at the local level.

Solutions that have Worked—Networking

The AGRINTER account shows why networking has been seen as one of the most viable ways to attack some of the problems of the agricultural information centers of developing countries. If isolation is the primary problem, then a structure that promotes interaction and reduces isolation has obvious appeal. Table 2 summarizes the ideas of information professionals from around the world regarding what solutions have the potential to make an impact on the problems they face. Networking of one sort or another is mentioned by most of them.

Networking as a concept is something that many agricultural administrators in developing countries can accept and support. Research networks have been created in many research areas and with

TABLE 2
SOLUTIONS BEING DEVELOPED FOR, OR CURRENTLY IN USE IN AGRICULTURAL LIBRARIES TO REDUCE CONSTRAINTS TO THE FLOW OF INFORMATION

Country (correspondent or author)	Networks?	Projects?	Technology?
Sub-Saharan Africa (Hailu)	- Use networks to channel funds to LDC libraries - Networks need internat'l finance		- Info Technol. facilitates the work of networks: •CD-ROM •Expert Systems •E-mail
Latin America (Barrantes)	- Informal groups at the nat'l level put together seminars, gifts & exchange, courses, horizontal technical assistance, input to databases	- Internat'l funding has provided training, new technol. Collection bldg. & new products and services have followed	- New technol. allows better storage & retrieval of info. and many d-bases - Technol. allows more time to devote to users
Malawi (Kinney)	- Dept. of Ag. Res. named as AGRIS input center - Links to CGIAR centers	- Document delivery from Univ. of Oregon - AGRICOLA on CD-ROM	- CD-ROM: •Adds status for info workers •Value of info enhanced •Quick access appreciated
Latin America (Siri)	CIP is actively involved in info. networks	- First CGIAR info. meeting	
Pac/Asia (Johnson)	- ULS, Lib. exchange shared catalogs - AGRIS has major effect - IIMI part of micro network	Most countries are succeeding in producing indexes and abstracts	- PC-sharing reduces isolation - Software like Micro-CDS/ISIS encourages cooperation - Use of technology elevates status of librarians
ACP (Af., Carib., Pac.) countries (Niang, Hartevelt & Dusink)	- RESADOC - CAGRIS - Others	- CTA supports numerous projects. Currently CD-ROMs	- CD-ROMs with d-bases & full-text & training
Internat'l (AGRIS)(Lebowitz & Participants Meeting)	- AGRIS is a formal, voluntary network	CD-ROM with Pan Amer. Health Org.	- CD-ROMs & AGRIS online
Internat'l (CABI)(Metcalfe)		- Africa Literature Service	- CD-ROM d-base
Argentina (Tuya)	- Network projects: SNICA-Ag. standards (AGRIS center) ULS SNICA mail Contents pages Reprography Training		- National & world bibliographies (suspended due to funding)
Colombia (Lopera)	Project (for university libraries) of sharing journal literature	- In 1980s libraries began to train professors to work with their students on info retrieval	
Latin America (Malugani)	- Interdisciplinary & integrated approach to science has augmented the whole info. structure		- Computerization of d-bases for SDI; searches

TABLE 2 *(Cont.)*
SOLUTIONS BEING DEVELOPED FOR, OR CURRENTLY IN USE IN AGRICULTURAL LIBRARIES TO REDUCE CONSTRAINTS TO THE FLOW OF INFORMATION

Country (correspondent or author)	Networks?	Projects?	Technology?
Ethiopia (Abraham)			
India (Bannerjee & Moitra) (Ahsan & Lal)	- 4 nat'l info ctrs. based in existing libs, w/ svcs. to networks of info. ctrs. - Computer & communication networks - Ag. info. network needed		- Beginning to automate - Bibliog of Agric. - Coop w/ AGRIS - New periodical d-base - Microfilming of older lit. - Need more microfilm resources - Need CD-ROM - Need Cornell core collection
Sri Lanka	Functioning network aids ag info transfer in country. Now need to network w/ neighboring countries	IDRC-funded network	
Vietnam (Vo-Tong Xuan)	- LDC scientists can get info directly from scientists in industrialized countries	- CGIAR centers need to give more attention to Nat'l Ag. Res. Systems	- Publish on floppy disk; scientists can make their own copies. - Needs stds. for hardware & software that all can use
Sahel (Rpt of RESADOC) (Niang letter)	"RESADOC is a success"	- Financing shared by many internat'l orgs. - RESADOC shares in POPIN-Africa network	- Microfilm - HP 3000 for d-base
China (Pan Shuchun)	- Network for sharing English journals	- Libraries are coord. by region for resource sharing	- Chinese characters for databases
Nigeria (Ibekwe & Azubuike/NAALD)		- Use of UNESCO coupons helps in acquisitions	
Southeast Asia (Syed)	- AGRIS needs to develop Level II activities, based on specialized info center concept - AGLINET works for "strengthening the strong." - Funding needed to help big libraries meet needs of "resource-poor" - AGRIS coupon scheme & local coupon schemes needed	Well-endowed libraries, like university libraries, should take the lead in cooperative projects.	Projects like Cornell project (Core lit.) bring technology to aid of DC's
Pacific (Foss)	Networking, where the commitments are from librarians and are for activities that they have authority to commit to themselves		- CD-ROMs - Computerized databases - Telecommunications

TABLE 2 *(Cont.)*
SOLUTIONS BEING DEVELOPED FOR, OR CURRENTLY IN USE IN AGRICULTURAL LIBRARIES TO REDUCE CONSTRAINTS TO THE FLOW OF INFORMATION

Country (correspondent or author)	Networks?	Projects?	Technology?
Cameroon (Baldwin)	- Participate in a nat'l info. network	- AGRIS input. - Nat'l bibliography. - No. of users climbed dramatically	- Library being fully automated. - Using CD's for subject searches
Zimbabwe (Matare)		- FAO has been approached for support to nat'l & regional (SADCC)	
USA (Vavrek)		- NAL's Rural Info. Center: technology & services to minimize the perceived distances between people	
Australia (Sanders)	- CSIRO network for resource sharing, professional contacts among librarians, exchange of ideas - New South Wales Dept. of Ag. libraries, a network of 11 libraries= small successful network		- New technologies, especially microcomputer & teleconferencing help to overcome isolation

TABLE 2 *(Cont.)*
SOLUTIONS BEING DEVELOPED FOR, OR CURRENTLY IN USE IN AGRICULTURAL LIBRARIES TO REDUCE CONSTRAINTS TO THE FLOW OF INFORMATION

Country (correspondent or author)	Ref. Tools?	Education?	Political Action?	Other?
Sub-Saharan Africa (Hailu)	**- Microfilm document collections from nat'l inst.**	**- Use networks to provide training opportunities.**		
Latin America (Barrantes)		**- Personnel with new technol. are more disposed to change & therefore more creative** **- Universities are redesigning their curricula**		**- Networks call the attention of decision-making authorities to the info. centers**
Malawi (Kinney)		- Special training in technology for CD-ROM projects is essential for success		
Latin America (Siri)	**- CGIAR Union List of Serials**	**- Research on technology adoption & effects in LDCs**		
Pacific/Asia (Johnson)		**- LDC projects must include money for training where including new technology**		**- Many very dedicated librarians. They manage even without $$ resources**
ACP (Af., Carib., Pac.) countries (Niang, Hartevelt & Dusink)	- CTA supports purchase of ref tools for ACP countries	**- CTA sponsors numerous training courses**		
Interna't. (AGRIS) (Lebowitz & Participants Mtg.)	**- AGROVOC Multi-lingual** **- Agrindex in language of user**	**- AGRIS training much valued by participants**		
Interna't. (CABI) (Metcalfe)	**- Sources of free mats.need to be identified**		**- Raise the priority of information provision** **- Funding agy. action needed** - Internat'l Service for Nat. Ag. Res. Reports (Ghana project) must have info. component	**- Better understanding of user needs through research** **- Research on utility of info.**
Argentina (Tuya)	**- CARIS & local CARIS** projects dbases	**SNICA supports training, seminars**		
Colombia (Lopera)	**- New audiotutorials for reference**	- Universities have mounted: User education seminars; self help packages for instruction		

TABLE 2 *(Cont.)*
SOLUTIONS BEING DEVELOPED FOR, OR CURRENTLY IN USE IN AGRICULTURAL LIBRARIES TO REDUCE CONSTRAINTS TO THE FLOW OF INFORMATION

Country (correspondent or author)	Ref. Tools?	Education?	Political Action?	Other?
Latin America (Malugani)		- Restructure the curriculum - More research needed. - Continuing ed. essential	- Convince gov'ts to support collection development	
Ethiopia (Abraham)		- Help from internat'l sector is needed	Need to influence decision makers	
India (Bannerjee & Moitra) (Ahsan & Lal)	- D-base of Indian ag lit. since 1944 <u>Bibliog of Indian Agric.</u> at IARI - Also other pubs., svcs. - Guide to Info Sources - ULS compilation planned	- 1-credit compulsory course in using info. (for postgrads) taught by Indian Ag. Res. Inst.		Limited translation services available on demand
Sri Lanka				
Vietnam (Vo-Tong Xuan)	Need CGIAR bibliogs. abstracts, research, bulletins, books, etc.			- Need PC's to improve publishing capacity
Sahel (Rpt of RESADOC) (Niang letter)	- 11,000 refs. in dbase - RESINDEX (5 vols.) - Other pubs.	- RESADOC has trained 500 people		- Marketing - Synthesis products for non-scientist
China (Pan Shuchun)	- SDIC will publish foreign Ag Union Serials List and New Books Union List	- News releases help to inform users		- Improve internat'l library exchange programs - Use of microfilm
Nigeria (Ibekwe & Azubuike/NAALD)	- Libraries should use more Nigerian pubs. - Libraries should catalog their own resources and not buy service	- Job eval./Job description - Better use of staff motivation	- Better, clearer budgeting by categories - More central planning	- Improve internat'l exchange - Friends of the library groups assist - Fee based services needed - Use of CGIAR center services and pubs for collections - Other free pubs. available (share sources)
Southeast Asia (Syed)		Training & attitudinal development for libns. is a key factor		- Attitude that solutions are within the power of the individual librarian
Pacific (Foss)				- Individual initiative - Do-it-yourself attitude

TABLE 2 *(Cont.)*
SOLUTIONS BEING DEVELOPED FOR, OR CURRENTLY IN USE IN AGRICULTURAL LIBRARIES TO REDUCE CONSTRAINTS TO THE FLOW OF INFORMATION

Country (correspondent or author)	Ref. Tools?	Education?	Political Action?	Other?
Cameroon (Baldwin)	- Rapid collection growth with US/French/Belgian/CTA support	- 40 staff; 2 MLS librarians trained. (ORSTOM & CIRAD support) - Hope to reactivate professional assn.	Libn. can communicate directly w/ the Minister	- Depository for FAO, World Bank, CGIAR, & CTA pubs.
Zimbabwe (Matare)				
USA (Vavrek)		- Librarians should convene inter-agency meetings for planning & cooperation	- Cooperation between librarians & extension agents & other community agents essential	
Australia (Sanders)	- Expert systems can be developed for training librarians	- Job rotation - Workshops - Mobile or regional short courses - Educate the public in needs of libraries & generate user support	- Libns. must communicate with & lobby senior mgt. to gain support for collections & services - Set goals & priorities with management - Be willing to meet criteria for service & financial budgeting	- Research to quantify value of lib. svcs. to the community - Better statistics to quantify use & usefulness of lib. svcs.

much success. Naturally, any endeavor that requires human cooperation is fraught with risk, but solidly based networks allow for situations in which everybody can be a winner.

Hailu (1989) describes the prerequisites for a successful information network based on an adaptation of the well-known standards for research networks described by Plucknett and Smith (1984):

—The problem must be clearly defined and a realistic agenda drawn up.
—The problem must be widely shared.
—Strong self-interest drives productive networks.
—The members must be willing to commit their own resources.
—Trained personnel are necessary to undertake specific tasks and to contribute to decision-making.
—There must be strong leadership.

To these prerequisites, Hailu adds that there must be external funding. He believes that this is just a reality of networking in the developing world, one that is especially true of formal networks where more than one country is involved.

Broadbent (1989) states that, from the donor's point of view, the payoff for networking is greatest where the least infrastructure is present and where a tightly defined problem exists. For information networks, information is the problem and collaborative effort is the network's driving force. The self-sustaining efforts that grow out of the network are very attractive to donors since they last far beyond the initial infusion of funds.

Some of the problems networks encounter result from ignoring one or more of the concepts. For example, when some members are not willing or not able to commit their own resources, the other members of the network will have to carry them. When trained personnel are not available, training funds and sources must be available for the work of the network to progress. If the mission of the network is imposed upon the group from outside, and if their own self-interest is not really involved, the network is guaranteed to fail.

Since some networks exist while still laboring under one or more of these disadvantages, there are always some people who conclude that networking itself is the problem. However, even those networks that cannot conform to some of the principles set out by Hailu can produce beneficial results. For example, RESADOC (Le Reseau Sahelien de Documentation et d'Information Scientifique et Technique, Institut du Sahel, Bamako, Mali) is a network that performs in an extremely difficult environment—the Sahel of Africa. Principal problems include the inability of some countries to participate, the lack of government motivation to participate in some countries, the lack of financing for some key activities, and the lack of communication resources in the area (*Le Reseau,* 1989). To these problems Niang adds that there is a great need for the network to develop a marketing plan (T. Niang, personal communication, June 7, 1989), and this need is demonstrated by the shortage of clients from outside the Sahelian Institute. It is a common problem among information centers—the need for better ways of letting the potential users know what services exist (see Harris, 1985b, 1988). In spite of the problems faced by RESADOC, however, the network is improving the information situation in its area. RESADOC has been involved in the training of more than 500 information professionals, including 8 microfilm technicians, who are a particularly valuable resource in the region. There is a database of publications, for which some, but not all, of the national centers send data. There have also been a number of publications, including some designed to make scientific materials more understandable to nonscientists. This is another extremely valuable service in the developing world and one of the most difficult to find (*Le Reseau,* 1989).

Another network that has faced problems and overcome them (N. Posnett, personal communication, April 20, 1989; Sutthi Chayodom, personal communication, April 28, 1989) is FADINAP—the Fertilizer Advisory, Development, and Information Network for Asia and the

Pacific, coordinated at Bangkok, Thailand. FADINAP was founded in 1978 and offered the possibility of a regional exchange of information and experiences by countries having similar problems organizing their fertilizer markets. Eighteen countries belong to the network which is supported by ESCAP (the Economic and Social Commission for Asia and the Pacific) also at Bangkok; UNIDO (U.N. Industrial Development Organization), Paris, France; and the FAO. Among the activities of the network are information collection and analysis and documentation services. During official visits to national research stations, documents are collected and added to the collection. Contacts are also listed in the central file, and follow-up activities include routine solicitation of additional information. National Liaison Offices (NLOs) supplement the collection activities of the network of correspondents. They also assist local users and direct questions that cannot be answered on site to the central documentation center. Likewise, when a difficult question arrives at the central documentation center, NLOs will be contacted to provide data. The activities of the information center include several publications, a computerized database, and a published bibliography. FADINAP also provides training for local information staffs (see Sutthi, 1987). Most recently, a directory of fertilizer-related projects has been prepared listing 120 development projects in progress in 1988/89.

Foss (in press; personal communication, 15 May 1989) talks about networking among the far-flung islands of the Pacific region, and illustrates the use of the concepts listed by Hailu in a very different environment. What Foss calls "a can-do network for libraries from small to tiny" has been started among the Pacific Island Nations. The initial funding for talks among potential members was provided by the Institute for Research, Extension, and Training in Agriculture (IRETA), University of the South Pacific, Alafua Campus, Apia, Western Samoa; the South Pacific Commission (SPC), with headquarters at Noumea, New Caledonia; and CTA in the Netherlands. All participants were librarians and specialists who actually provide services and perform cataloging. All had the authority to make decisions concerning internal operations. The group agreed to certain cataloging and bibliographic standards; to use CDS/ISIS software (database management software available from Unesco without cost to developing country institutions) and a common format; and to exchange databases in electronic formats. Training in the use of the software will be provided by Unesco. A directory of agricultural personnel will also be produced, coordinated by IRETA (see also Flower, 1987; Walton, 1989).

There are many other networks that have been successful in meeting the needs of agricultural information users both in the developing and developed world. Some networks are active within only one country, and these can be particularly valuable in increasing professionalism and in abetting resource sharing. For example, Kinney (1989) discusses a microcomputer based bibliographic network in Malawi and points out that it led to increased professional prestige; Montaño de Mayolo (1987) discusses a local subnetwork of the Colombian national network for agricultural information and tells of the cooperative projects and professional seminars that group mounted; and Tuya (1986) discusses the national agricultural information network in Argentina and its contributions to the national bibliography.

It is interesting to note that networking is also the solution proposed for the problem of isolation in Australia. Sanders (1989) writes of the suggestions that arose in a conference entitled "Libraries Alone: Rural and Isolated Libraries." He wryly notes that "many problems of isolation are merely shared, and not solved" (Sanders, p. 49). However, he goes on to discuss the agricultural information network of CSIRO (Commonwealth Scientific and Industrial Research Organisation with headquarters in Canberra, Australia). This is the largest information network in Australia, and Sanders cites it as an example of what networks can accomplish. He also describes a smaller unnamed but still very successful network at the New South Wales Department of Agriculture.

Crowther (1984a) calls attention to one of the dangers of information networks. He believes that they concentrate on bibliographic information to the exclusion of potentially more valuable indigenous information. Bell (1986) and Broadbent (1989) echo this concern. Broadbent points out that:

> One underutilized and vast source of information is the people themselves living in subsistence or marginal economic circumstances. The people are the source of information about what is happening....An alternative may be to look inward for self-sustaining approaches, even though these are not growth-based. The record of achieving the objectives of economic development in subSaharan Africa over the last 20 years has not been good. Therefore, a rethinking of the long-term consequences [might bring] a different perspective to considerations about the value of information and the use of indigenous knowledge. (p.12)

He continues:

> Putting indigenous knowledge with useful outside knowledge would seem a good answer, but very often attempts to tap indigenous knowledge are limited by fixed perceptions of development objectives; negative attitudes toward people in marginal or disadvantaged circumstances; and fragmentation of services...marginal peoples explain what they do in cultural terms that seldom correspond to the scientific world view....Local community knowledge is too often disregarded by scientists and administrators, and its pragmatic basis in experience is overlooked....Giving a stronger voice to indigenous knowledge would help to diminish the isolation between planners and the people being planned for. (pp. 12-13)

Technology-Based Solutions—Will They Work?

Computer-based technologies or information technologies (IT) are influencing the agricultural information sector in the developing world just as they are in more developed countries (see Table 2). However, while it is already clear that the ultimate effects of computer-based technologies will be revolutionary in the heavily industrialized world, it is less obvious what the effects will be elsewhere. Some experts predict that information technologies will enable the countries of the tropics to have better access to information (Van Hartevelt, 1987, 1989; Kennedy Olsen, 1989a, 1989b; Ritzler, 1989; Schützsack, 1989), or "close the gulf between rich and poor countries" ("Computers close...," 1986, p.41) while others predict (King, 1982) or fear (Davies, 1985; Thorpe, 1984) that the effect of these technologies will only be to widen the gap between the North and the South—the more and the less developed countries.

The Optimistic View

There are a number of advances in technology that lead to an optimistic viewpoint. First, as computing power continues to become less expensive and storage capacity increases, it is possible, and even desirable, to mount small-scale, decentralized operations. It is no longer necessary to locate a database or a processing unit on one big central mainframe computer. This is important in that it allows disparate institutions to retain local control while networking resources. Second, as the cost of software skyrockets, and the cost of hardware declines, developing countries may be able to expend the resources to produce locally applicable software on their relatively inexpensive imported machines. Labor is not in short supply in these countries, and it is well within the potential of quite a number of developing countries to produce (if not necessarily to market) highly useful software packages (several caveats to this optimistic view will be discussed later). Third, while fully developed telecommunications infrastructures are lacking in almost all of the developing world, this has not stopped many of the countries from developing packet-switching networks (special telecommunications networks for data transfer). The developing world is fully accustomed to leap frogging in technological development simply omitting inconvenient steps in the path followed by the heavily industrialized countries and going on to the future.

The introduction of computer-based technologies can change the status of the librarian or information worker and the value that researchers or administrators place on the information itself. Lopera Quinceno (1988) and Kinney (1988) discuss the positive impact of IT on librarian status and on the librarian/user interface in two widely different environments. Dextre Clarke (1989) also notes that respondents to a survey felt that there was improvement in the appreciation for the library service when CD-ROM databases were available. Barrantes (personal communication, May 24, 1989) notes that librarians introduced to computerization tend to be more flexible and more creative than before, and that this has a positive effect on their work.

Slamecka (1985) believes that the most important effect of information technologies in the Third World will be the increasingly effective management of information. He points out that the concept of actively managing information has not been common in the Third World, but that information technology forces institutions to analyze the need for information management and to support it. The development of computerized databases in agriculture and the growth of the surrounding infrastructure would support this viewpoint. Slamecka also notes that marketing information technology and its applications is different than the traditional approaches to improving information awareness, which have not been very effective, in that it is necessary to demonstrate the empirical utility of the product. Slamecka goes on to postulate that since the typical literate person in a developing country does not consider information a resource of value or utility in solving problems, he does not value libraries or information systems. This is a problem discussed repeatedly by agricultural information workers. But information technology is changing the educational system and the work paradigm, and, over time, it appears to be changing the concept of the importance of information.

The Pessimistic View

One of the greatest worries about new technologies is that they will drive the information process instead of answering to the real needs of the users (Davies, 1985; C. Siri, personal communication, May 5, 1989). Users may become so enchanted with the computer's facility in delivering an information source that they overlook better sources.

Others (Kinney, 1988; Thorpe, 1984) worry that there will be insufficient training to support the use of computer based technologies. This fear is valid since lack of adequate training is prevalent throughout the world. In the developed countries much of the learning process is informal and is supported by colleagues and friends. Where computers are scarce, the informal learning resources will not be present.

There is also a fear of cultural identity loss. In the developing world, as in heavily industrialized countries, concerned people feel there is some chance that the computer will dehumanize society. Additionally, in some parts of the developing world, there is concern that computer-based technologies may be biased toward other cultures and specifically toward the cultures of the United States and Western Europe.

Next, there is concern for the expense of computer-based technologies compared to print. This will no doubt remain a pressing concern as long as the first step in the use of these technologies must be the purchase of the equipment itself.

While the above are legitimate concerns, they are probably not the strongest reasons why many developing country professionals look at information technology from a pessimistic point of view. They are most concerned about the forces of superpower economics on their national development in the area of information technology.

The more sophisticated developing countries (India, Mexico, Brazil, Malaysia) have already seen the need to protect their computer industries in order to keep the market from being dominated by the countries of the North. They have been reasonably successful in terms of hardware production, and thus they market computer technology to their citizens and to trading partners. In these same countries and others, software production is also well underway. But this development could be blocked by developments in the area of U.S. patent law.

Brian Kahin, attorney and consultant to EDUCOM (an interuniversity educational computing council based in Boston, MA, USA), believes that developers of software may be able to patent the basic concepts used in software (for example, the concept of the spreadsheet) and block any other software developer from using them by claiming patent infringement (B. Kahin, communication to Office of Library Affairs, California State University, April 12, 1989). Since a patent gives the patent holder a seventeen-year monopoly on an invention, and a single computer program may contain from 10 to 1000 applications that could be patented, this could effectively block other countries' software development where the U.S. market is concerned. The costs of researching patents are very high, and the risks are great. Kahin believes that this is bound to slow development and raise costs.

Current Information Technology Projects

Many countries continue to adopt information technologies to mount agricultural bibliographic databases. One of the most recent to undertake this work is China (Pan Shuchun, personal communication, May 11, 1989). The Scientech Documentation and Information Center (SDIC) of the Chinese Academy of Agricultural Sciences in Beijing is using microcomputers to input and edit citations and abstracts and a laser printer to produce printed *Abstracts on Horticulture,* Chinese version. IDRC is working with SDIC to produce the database with Chinese characters. Problems are caused by inadequate numbers of characters of national standard that the system can manage (6,763 at present) and by the fact that agricultural information uses some uncommon characters. However, work continues. As is often the case, information technology is being used in combination with networking, and a resource sharing network for journal literature is also under development.

Bibliographic software continues to be an important factor in information development. The CDS/ISIS and Micro-ISIS database management software for IBM (International Business Machines) computers (developed and distributed by Unesco) and the MINISIS database software for Hewlett-Packard 3000 minicomputers (developed by IDRC) have been used for most developing country databases, revolutionizing the information infrastructure. The Unesco software, Micro CDS/ISIS, is especially influential in carrying the information infrastructure forward since it is widely distributed across the world, it can be used on inexpensive microcomputers, and the products it generates can be shared. Wordperfect software (Wordperfect Corp., Orem, Utah, USA), which is available in French and Spanish versions, is also widely used, and, in spite of its cost, INMAGIC (INMAGIC, Inc., Cambridge, MA, USA) is a popular choice for database development. Johnson (1987), Kinney (1989), and Eres and Bivins Noerr (1985) discuss networking of information centers using microcomputers.

One of the most hopeful new technologies for the developing world is CD-ROM ("Discussions," 1989; Dextre Clarke, 1989; Van Hartevelt, 1987, and 1989; Ritzler, 1989). Several projects are underway.

CAB International has just finished the evaluation of its CD-ROM database in twenty-three organizations, eight of which were in the developing world (Beaumont, 1988; Dextre Clarke, 1989). Users were generally positive about the product although search software will be improved in future releases. They liked the fact that end users could do their own searching and that, especially since no telecommunications costs were incurred, the product could be used to execute lengthy search strategies and for training. Cost and training were the only areas of concern. (Cost will probably continue to be an issue as long as publishers try to charge more for CD-ROM than for other formats.)

The CGIAR secretariat is in the process of producing a prototype set of the research publications of the CGIAR centers on CD-ROM (Frierson, personal communication, May 1, 1989). This prototype disc, along with several other products, will be made available to eight libraries in the tropics as a pilot project financed by CTA (CTA and KIT..., 1989). These products include: AGRICOLA on disc; the Maize Germplasm Bank of CIMMYT (Centro Internacional de Mejoramiento de Maiz y Trigo—the International Center for Maize and Wheat Breeding in El Batán, Tezcoco, Mexico); the *Abstracts on Tropical Agriculture* and *Abstracts on Rural Development in the Tropics* of the Dutch Royal Tropical Institute (Koninklijk Instituut voor de Tropen, KIT) at Amsterdam, the Netherlands; and a French bibliography being produced by ORSTOM (Office de la Recherche Scientifique et Technique de Outre-Mer, the French development research agency, at Paris, France), INRA (Institut National de Recherche Agronomique, the National Agronomy Center of France at Versailles) and CIRAD (the Center for International Research and Development Cooperation at Montpellier, France). Libraries in Trinidad and Tobago, Western Samoa, Papua New Guinea, Cameroon, Kenya, Mali, Zambia, and Zimbabwe will receive the discs as well as a workstation and CD-ROM player. Training in the use of the discs and in trouble-shooting techniques will be provided. Document delivery is to be provided separately by means of coupons from the British Library, Unesco, and CNRS (Centre National de la Recherche Scientifique, Paris, France).

AGRIS is collaborating with the Pan American Health Organization (PAHO) to produce its database on CD-ROM using the Micro

CDS/ISIS software for searching. It is possible that Micro-ISIS is not the best possible search software for a CD-ROM product since it requires a good deal of training to manage it. However, it has the very important advantage of being subsidized, and an additional advantage is that it is already in use in so many developing country libraries.

NAL, as the U.S. AGRIS Center, has made arrangements for Silver-Platter to develop, commercially, the non-U.S. part of the AGRIS database. SilverPlatter may market this product in the developing world, as well.

In an even more ambitious project, Cornell University, with Rockefeller Foundation funding, has begun a project to qualitatively select the core literature of agriculture which will then be stored with its full text on optical disc. The core literature will be divided by discipline into eight separate volumes. Each volume will include a core list of primary monographs, a core list of primary serials, a list of reference collection titles, and specialized literature appropriate for the discipline. The lists can be divided by geographic region and commodity. The project will offer developing countries the opportunity to have the full text of some of the most important books and articles for the study and research of the discipline with the convenience of the computer-based technology. It is expected that funding will be sought from donors to subsidize the purchase of this technology for the developing country institutions once the product is ready (Kennedy-Olsen, 1989a, 1989b).

Projects such as the Cornell Project, the CGIAR disc, the AGRIS/PAHO project, and the CTA/KIT project are especially important at present. Optical disc technology makes scientific communication relatively inexpensive to produce, handle, ship, and store. The mailing and shipping costs alone make the technology attractive to librarians in developing countries (Vo-Tong, X., 1989). Publishers who depend on print-based revenues are understandably reluctant to experiment with optical disc unless they can charge more than they do for print (see for example, Dextre Clarke, 1989; Malcolm, 1989). Librarians in developed countries are reluctant to part with print-based information systems and to undertake the design of the entirely new types of systems that are sure to follow in the wake of optical disc technology. Donors could play a key role in helping to overcome the inertia if they believe these technologies have the potential to act for the good of the developing world.

Conclusion

Libraries and information centers in the developing world suffer from most of the same problems that plague libraries everywhere. They do not have money to build needed collections. They have inadequate staff to get the work done. Professionals do not have sufficient contact with their peers, and there is no time or money for professional development. Library users do not always appreciate the library and almost never understand how much work it takes to get the job done. Librarians can't usually quantify the good work they are doing. Their administrators do not want to allocate the money needed to support a top-rate information service since they think other needs have priority.

The difference in the developing world is that the problems are more acute. This stems from the cultural traditions in which books, libraries, and teaching students how to conduct research are not parts of the educational curriculum and in which publishing houses cannot find sufficient markets to survive. In these cultures, people do not automatically turn to the library for information.

Over time, scientists and researchers, in agriculture as in other technical fields, are learning that information availability is crucial to the success of their activities. Administrators and planners have been slower to see the value of information, but that awareness is growing too.

The information infrastructure that will serve developing countries best is one that meets the needs as perceived in the various countries. If the highly industrialized countries can help to meet those needs, both the developed and developing worlds will gain in the exchange. At the very least, the industrialized world needs to be aware and take care that the policies and practices they adopt do not directly harm developing country infrastructures.

Acknowledgments—List of Contributors

The following people kindly sent articles and letters with their ideas about the problems and successes of information workers in their respective geographic areas. Inasmuch as the author of this paper has been able to present a global view, it is due to their assistance. Many of the thoughts they sent are summarized in Tables 1 and 2, and others are represented by the literature cited in the references.

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Where references might prove difficult to locate through conventional U.S. library mechanisms, the name of a contact person in parentheses at the end of the reference is included. The addresses of contact persons are listed in Appendix A. When requesting an article from these contact persons, good form mandates offering payment of direct costs incurred, or the exchange of a similarly valuable piece of information from sources available in the country of the person doing the ordering.

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